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ENGINEERS OF THE U. S. RECLAMATION SERVICE.

We reproduce herewith an excellent group photograph showing a considerable proportion of the engineers connected with the U. S. Reclamation Service, having in charge the construction of reservoirs and canals for the improvement by irrigation of large tracts of land in the arid region. The photograph was taken on the occasion of a general conference of the engineers engaged in this work, held at Ogden, Utah, Sept. 15-18, 1903. These conferences have become a pleasant and useful feature of the work which the Reclamation Service is carrying out, and one very

A GROUP OF ENGINEERS OF THE U. S. RECLAMATION SERVICE.

(From a photograph taken at Ogden, Utah, Sept. 16, 1903. The names of those comprising the group are printed below in their approximate relative position.)

Malcolm Moody, L. A. Nares, Gifford Pinchot, Thos. Hailey,
R. F. Walter, A. L. Fellows, J. T. Whistler, C. J. Blanchard, W. C. McCune,
M. De Forest, T. A. Noble, A. E. Chandler, M. C. Hinderlider, Wm. Bostaph,
N. H. Darton, Jere. Ahern, G. L. Swendsen, D. W. Ross, J. E. Field, Geo. Y. Wisner, J. B. Lippincott,
C. H. Fitch, H. N. Savage, W. M. Reed, A. P. Davis, F. H. Newell, W. H. Sanders, L. H. Taylor, Morris. Bien.

largely attended has just been held in Washington. The attempt to secure a group photograph of those in attendance on this conference, however, was unsuccessful, and we therefore present the picture taken some time ago. While it is deficient in omitting many prominent engineers who have joined the Reclamation Service during the past 15 months, it does include so many well known engineers that it will interest, we are sure, very many of our readers.

It may be noted here that the amount of engineering construction work to be carried on under direction of this corps of civilian engineers will very soon approach in magnitude the amount of work on river and harbor improvement carried on under direction of officers of the Corps of Engineers of the Army.

THE USE OF SALT WATER FOR FIRE PROTECTION AND OTHER PURPOSES AT U. S. NAVY YARDS.

Salt water supply systems, chiefly for fire protection, are in use at the Norfolk, the New York and the Puget Sound (Bremerton, Wash.) U. S. Navy Yards, and the material is on hand for constructing a system at the U. S. Naval Station, Key West, Fla. The latter system will connect with the salt water mains of the city of Key West, but a high pressure pump will be installed for use in case of fire. Through the courtesy of Rear Admiral Mordecai T. Endicott, U. S. N., Chief of the Bureau of Yards and Docks, Washington, D. C., and of the commandants and civil engineers of the several yards, we have obtained information regarding the four systems named. Our direct informants are given at the head of each of the four descriptions. The systems are described in the order of their installation, and the information is understood to be correct to January, 1905.

U. S. NAVY YARD, NORFOLK, VA.

(Fred Thompson, Civil Engineer, U. S. N.)

HISTORY AND USES.—The major portion of the system was installed in 1897, since which date there have been additions from time to time. Besides fire protection, the system supplies salt water for automatically flushing the various water closets in the yard.

PUMPS.—There are two duplex pumps with a capacity of 600 gallons per minute, and two 1,000-gallon Underwriter pumps, all four of which may be used in case of fire.

PRESSURE.—The whole pipe system is always under pressure. The maximum pressure on the pipe system is 200 lbs. The constant or ordinary pressure is about 40 lbs. This is afforded by one of the 600-gallon pumps, which is always going, and supplies the water closets.

MAINS.—There are about 13,100 ft. of extra heavy cast-iron mains, divided as follows: 12-in., 1,830 ft.; 8-in., 2,860 ft.; 6-in., 3,455 ft.; 4-in. 4,955 ft. The joints are of lead and no leaks have been detected.

FIRE HYDRANTS.—There are 49 hydrants, some two-way and some three-way. Those with iron valve stems and soft valve seats of white metal (presumably the earlier ones.—Ed.) have corroded freely. The hydrants with composition valve stems and seats have proven satisfactory.

VALVES.—Nothing but composition wedge gate valves are used.

PROTECTION AGAINST CORROSION.—The pipe was coated by the Angus-Smith process. As a protection against corrosion in pumps, hydrants and valves, brass is used wherever possible, which seems to withstand the corrosive action of the water. The water at this Navy Yard is never very salt, being almost fresh at ebb tide, but it contains a large amount of organic matter, which favors the growth of algae, etc., within the pipe system. This foreign growth would soon choke the pipes were not frequent hydrant flushing resorted to.

MERITS AND DEFECTS.—The salt water system at this Yard has given satisfaction so far as the use of salt water is concerned, with the exception that it favors the growth of foreign matter, as above stated.

PUGET SOUND NAVY YARD, BREMERTON, WASH.

(A. C. Lewerenz, Civil Engineer, U. S. N.)

HISTORY AND USES.—The first installation was completed on Sept. 10, 1901. This included the pump and about one-fourth of the present mileage of pipe. On Jan. 15, 1902, and again on May 27, 1903, extensions to the pipe system were completed. The system is used for various flushing purposes, particularly to flush water closets, as well as for fire protection.

PUMP.—There is only one pump, a Worthington Underwriter duplex fire pump, with a capacity of 1,000 gallons per minute, against a pressure of 180 lbs. and with a working steam pressure of 70 lbs.

PRESSURE.—A pressure of 40 lbs. is maintained during the day and 60 to 100 lbs. at night. The pipe system is always under pressure.

MAINS.—There are 250 ft. of 12-in. suction pipe and 6,720 ft. of 8-in. force main, all of cast iron. Where above ground the 8-in. pipe has flanged and bolted joints. No tapping of cast-iron pipe for screw connections was allowed, nor the use of any screw jointed wrought-iron pipe. Wherever a connection to cast-iron pipe was necessary special flanges, cast on, were required.

FIRST HYDRANTS.—There are 20 two-way hydrants, connected to the mains by 6-in. branches. (The specifications for these appear to have been substantially the same as those cited under New York.—Ed.)

VALVES.—(The specifications for these are also substantially the same as those given under New York.—Ed.)

PROTECTION AGAINST CORROSION.—For the pumps it was specified that special attention must be given "to protection against rust and corrosion from salt water." The mains were coated by the Angus-Smith process. The valves and hydrants have bronze working surfaces and have their iron ports coated by the Angus-Smith process.

SPECIAL DEVICES.—A Fisher governor is used for the close regulation of pressure.

MERITS AND DEFECTS.—The merits of the system here consist in the inexhaustible supply of water from which to draw; the greater efficiency of salt water over fresh in case of fire; the saving of fresh water in many cases where flushing is required, particularly of water closets; and its readiness for immediate use at all times—day or night. No defects in the system have thus far been noticed.

NEW YORK NAVY YARD.

(R. C. Hollyday, Civil Engineer, U. S. Navy.)

HISTORY AND USES.—The system was put in operation in the spring of 1902 and has been extended since as has been necessary. The system at this yard not only serves to protect the buildings from fire by connecting with the hydrants, but in many of the buildings there are salt-water risers and hose connections. Many of the ships while lying at the quay wall or in dry dock have connection made with the salt-water system. This system also supplies the water for flushing the numerous latrines about the yard. The 50-lb. pressure maintained at all times is sufficient to operate syphons which are in constant use in draining excavations. The salt-water system is also used in testing the water-tightness of compartments of ships under construction and under repair. The salt-water hydrants are used in flushing the streets when necessary.

PUMPS.—There are two duplex pumps, each rated at 2,000 gallons per minute under 200 lbs. water pressure and 100 lbs. steam pressure, and one duplex triple expansion pump designed for 1,500 gallons per minute under 200 lbs. water pressure and 100 lbs. steam pressure.

PRESSURE.—The pipe system is constantly under pressure, except on rare occasions when the pumps are shut down for cleaning the salt-water well. The normal pressure is 50 lbs. and the fire pressure is 125 lbs.

MAINS.—There are 26,000 ft. of extra heavy cast iron, bell and spigot, water pipe, in lengths as follows: 12 in., 7,000 ft.; 10 in., 2,500 ft.; 8 in., 5,000 ft.; 6 in., 9,500 ft.; 4 in., 2,000 ft.

FIRE HYDRANTS.—There are 100 in use, bought under the following specifications:

All the hydrants to be of the following pattern and construction. To suit a depth of 5 ft. from pavement to bottom of inlet pipe, with a 6-in. bell connection, two 6-in. inlet valves (main and supplementary), four 2½-in. hose outlets and no steamer outlet (or a part of the hydrants with two 2½-in. hose outlets and one 4½-in. steamer outlet, if so specified by the civil engineer of the New York Yard); the stocks or standpipes of all the hydrants to screw into the base elbow or shoe, with an outside sliding frost-case permitting the hydrant proper, together with the main valve and its seat and the waste valve and its seat, to be unscrewed and removed for repairs without disturbing the earth and without the loss of water or the independent closing of any valve in the water system, the supplementary valve automatically shutting off the water when the hydrant and main valve are removed; the two 6-in. valves to be conical, opening against the water pressure and closing with it; the upper or main valve to be attached to the main stem, with its guide and the waste valve sliding in a solid bronze cylinder, this bronze cylinder to be an integral part of the main stock or standpipe, but not to be the medium by which the later is screwed to the base elbow or shoe; the lower or supplementary valve to have a bronze stem and follower and an extra-heavy bronze spring working in a bronze-lined chamber below, to be operated by contact with the main-valve stem, and so arranged that all valves open and shut with every opening and shutting of the hydrant, and so that the waste valve closes before the lower valve opens and opens after the lower valve closes, thus preventing waste of water under high pressure; all outlets of the hydrant to have smooth curved surface approaches, with no rectangular edges or rough surfaces in the path of the outrushing water; all working parts of the hydrant to be of bronze or bushed with bronze in such a manner as best to protect against salt-water corrosion; after all the iron parts are finished and the rigidly-attached bronze parts are screwed or driven in place, and before any rust shows on the iron parts, the whole to be heated and dipped in a vat of hot coal-tar-pitch varnish, according to the Angus-Smith process, the coating on the bronze working surfaces to be afterwards removed without disturbing the coating over the joints between bronze and iron; the large threads on the end of the main stock screwing into the bronze ring in the shoe base, if of iron, to be cut to a loose fit, and to be dipped with the rest, and the coating to be wiped smooth and uniform with a brush upon the removal from the vat; all other screw threads of iron or steel which would otherwise be exposed to the continuous action of water, to be capped with bronze or otherwise absolutely protected from such contact with water; and all parts of the hydrant to be of amply sufficient weight and strength to withstand, without leakage or injury, a hydrostatic pressure of 250 lbs. per sq. in.

VALVES.—The valves have double gates, independently adjustable, the bodies being cast iron, the working parts and contact surfaces in bronze. The specifications were as follows:

All the valves to be of extra weight, intended for high-pressure salt-water fire service, of ample strength to withstand without injury a pressure of 200 lbs. and occasionally of 250 lbs. per sq. in., and of the following construction: Cast-iron bodies with bell connections, double gates independently adjustable, each gate or disk suspended by a central trunnion and free to revolve its whole circumference (thus securing a new contact at each seating), and so arranged that the central pressure is entirely removed and the disks freed from their seats before being raised; all the working parts and contact surfaces to be of bronze, and of the best possible composition and construction to resist wear and corrosion by salt or brackish water, the wedging surfaces on the spreader to be harder bronze than those on the revolving disks; the upper end of spreader nuts and the inner surface of top of case to be so finished as to make a close fit when valve is wide open, so that stuffing-box packing may be renewed with only trifling leakage without shutting down the valve; and after all the iron parts are finished and the rigidly-attached bronze parts are screwed or driven in place, and before any rust shows on the iron parts, the whole to be heated and dipped in a vat of hot coal-tar-pitch varnish according to the Angus-Smith process, the coating on the bronze working surfaces to be afterwards removed without disturbing the coating over joints between bronze and iron.

PROTECTION AGAINST CORROSION.—The pumps have composition valves, and all bearing and working surfaces are of composition. No precautions to prevent corrosion of the cast-iron body of the pump, aside from the contact surfaces, is necessary. The pumps have exterior stuffing boxes, and the plunger is of composition.

The pipes and specials are coated, inside and outside, with coal-tar-pitch varnish, according to the Angus-Smith process.

The valves and hydrants have bronze working surfaces and have their iron surfaces coated by the Angus-Smith process.

MERITS AND DEFECTS.—In the two years before the installation of the system was commenced this yard suffered severely from two disastrous fires. Civil Engineer Asserson, U. S. N., designed and laid out the system, and since that time there has been no serious fire at the yard, so that it is impossible to state just how efficient the system would be in case it was severely tested. The various supplementary uses to which it is put make it a very useful adjunct to the work being carried on in this yard. As far as has been noted up to the present time the salt water has no injurious effect upon the pumps, pipes, valves and hydrants; only where connections have been made with pipes not treated as the pipes in the main system and where there are valves not specially constructed for this use, has difficulty been encountered. The chief defect of the system, and practically the only one of any moment, has been experienced with the intake pipe from the water-front to the salt-water well in the pump house. On account of the immense amount of floating debris in the channel at the navy yard, the screen is soon clogged and the supply of water thereby diminished. This defect is being remedied by the installation of two screens in a specially constructed intake chamber, so that one screen can be raised and cleaned at any time.

At rare intervals it is necessary to close the gate at the intake and drain off the water from the salt-water well in order to clean out the sediment which accumulates rapidly in the bottom of the well; this difficulty will doubtless be overcome by building another well and connecting the pumps to both wells independently.

NAVAL STATION, KEY WEST, FLA.

(F. C. Brown, in charge Department Yards and Docks.)

HISTORY AND USES.—The material is all on hand for the installation of the system, but owing to some contemplated improvements, and the filling in of a portion of the area in which the system is to be located, no portion has been laid.

When the system is installed connections will be made with the mains belonging to the city of Key West, but there will be a fire pump, as stated below. The system will be used to wet down streets, as well as for fire protection.

PRESSURE.—The pressure maintained in the city mains is about 33 lbs., which will be sufficient under ordinary conditions.

PUMPS.—A Worthington high-pressure fire pump, of 1,000 gallons capacity per minute, against a pressure of 180 lbs. and with 120 lbs. working steam pressure, is proposed.

MAINS.—There will be 2,335 ft. of cast iron mains. Most of this will be 8-in. pipe, not less than 0.61-in. in thickness of shell. All pipe is specified as being "for high-pressure salt-water fire service."

HYDRANTS.—There will be six hydrants. (See specifications under New York.—Ed.)

VALVES.—(See specifications under New York.—Ed.)

PROTECTIONS AGAINST CORROSION.—(See New York.—Ed.)

MERITS AND DEFECTS.—As the system is not installed this question does not apply, but from some observations of the city system I must say that there is unusual corrosion where the mains are tapped for small connections. In several instances I have observed that the pipe has rusted entirely away from the tap connection, but the pipe line seems to be well preserved in other respects. I had occasion to cut the line and put in a T-connection and found the pipe in good condition.

A NEW DESIGN OF CLAM-SHELL AND ORANGE-PEEL DREDGE BUCKET.

The accompanying cuts represent a new self-filling bucket, which is made in both the clam-shell and orange-peel types, although the cuts show only the orange-peel type.

The principal feature is in the system of operating levers, and it will be seen from the drawings in Fig. 1 that the bars connecting the pivoted

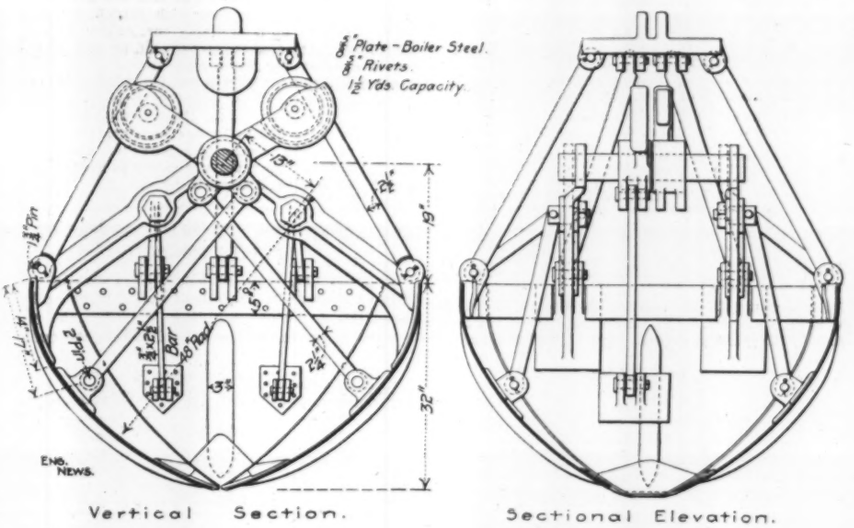


FIG. 1. A NEW ORANGE-PEEL DREDGE BUCKET.
Mayo & Bailey, Makers; Chicago.

levers with the sections of the bucket shell are attached well down in the shell, thus giving greater power than if attached nearer to the top of the bucket. The hoisting cable passes around the sheaves on the levers and has its end attached to the head frame of the bucket. The second cable is attached directly to this frame. The bucket is held at any point by this latter cable, and dumped by paying out the hoisting cable, which allows the bucket to open.

For buckets used in unloading boats, barges or cars, an important feature is that two of the four sections end in a flat lip 15 ins. wide, and when the bucket is open these project about 12 ins. below the sharp points of the other two sections; thus the floor of a car or vessel is not liable to injury by the points of the bucket when dropped. This is clearly shown in the view of the open bucket in Fig. 2. For buckets used in dredging and excavating, the flat lip is made narrower.

The orange-peel bucket is said to be specially adapted for working in soft coal, and it will fill to its full capacity when working in large-sized soft coal, as shown by the view of the closed bucket in Fig. 3. When rested (not dropped) upon a pile of coal, ore, stone, etc., the action of the levers and the shape of the shell cause it to settle down into the material and take a full load in the act of closing. The tendency is to dig down instead of scraping along the pile, and when working in soft coal this reduces the breakage of the large lumps. As the bucket does not need to be dropped it can be used to advantage in unloading boats, as when lowered it can be swung to either side under the deck and so used to clean out the material between the hatchways. In unloading 40-ton cars of Hocking lump coal, under actual working conditions a 2-ton bucket of this type unloaded about 85% of the coal in the car in an average of 30 to 35 minutes.

The buckets can be used on any hoisting tower, crane, bridge tramway, dredge or derrick having a two-line hoist; and can be used on a one-line hoist by the addition of an idler drum and counterweight. The buckets are made by Mayo & Bailey, First National Bank Building, Chicago, and we are indebted to them for plans and information.

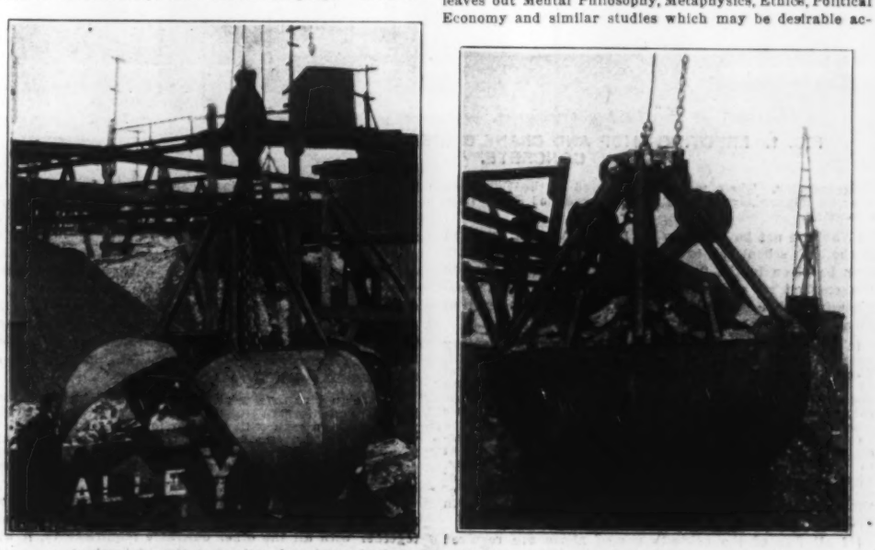
DESIRABLE ENTRANCE REQUIREMENTS FOR ENGINEERING COLLEGES.*

By William Kent,† M. Am. Soc. M. E.

The Lyman Cornelius Smith College of Applied Science was organized by Syracuse University in 1901, and in September, 1902, its new building was opened and courses were given in Civil, Electrical and Mechanical Engineering. The entrance requirements were framed to be in harmony as far as possible with those of the Science courses of the Liberal Arts College of the University, but with a higher requirement in Mathematics and fewer electives. As stated in the University Catalogue for 1902 and 1903 they were as follows:

English; History; Mathematics, including Advanced Algebra and Solid and Spherical Geometry; also three additional subjects selected from the list of optional entrance requirements to the Liberal Arts College [Greek, Latin, Spanish, German, Physical Geography and Geology, Physics, Chemistry, Botany, Zoology and Free-hand Drawing].

According to these requirements a student was obliged to have had High-school courses in five classes of subjects, namely: English, History, Mathematics, Physical Science (Physics or Chemistry) and Modern Language. Each of these subjects belongs to a distinct educational group and cultivates a separate group of intellectual faculties. The three additional subjects might under these requirements be selected from the same groups. Thus a student presenting German and Physics as two of the required subjects might present Latin, French and Chemistry as the other three. He then would not have gone outside of the five groups and would not have as broad and liberal an education as a student who had presented as his extras Latin, Free-hand Drawing and Botany or some other natural science.



FIGS. 2 AND 3. VIEWS OF NEW ORANGE-PEEL BUCKET, OPEN AND CLOSED.

A change in the direction of broadening the entrance requirements so as to require six groups was made in the present year, namely, that of including Free-hand Drawing as one of the essentials and leaving only two extra subjects. The student therefore has now to present subjects in six groups instead of five as heretofore, but eight separate subjects are still required.

It is now proposed to make another change, so as to require studies in seven groups, and to drop all additional requirements, making only seven subjects in all that need be offered, but they must all be in different groups. The seven groups are as follows:

I. English: the usual college requirements.

II. History: Greek, Roman and Advanced United States.

III. Mathematics: including Advanced Algebra and Solid and Spherical Geometry.

IV. Free-hand Drawing: one year of the usual High-school course.

V. One modern language: two years of French or German or Spanish. Two years of Latin will be accepted as an equivalent of one year of a modern language.

VI. Physics or Chemistry: one year of either, with laboratory practice.

VII. Physical Geography, Geology, Botany, Zoology: one year of either, or half year each of Physical Geography and Geology, or half year each of Botany and Zoology.

It is submitted that the proposed entrance requirements offer the following advantages: First, the requirement of seven studies instead of eight makes it easier for high schools to give a thorough preparation. Second, they will decrease the number of conditions of entering students. Third, seven subjects selected from the seven groups, each studied with proper thoroughness, gives a more liberal and broader education than eight subjects from the five groups including three electives which may be selected from the same five groups. Fourth, they include Drawing and Natural Science, without which no one can rightly be said to have a broad and liberal culture. Fifth, by making options in Language and Physics and Natural Science, the requirements favor those high schools which are equipped to give some optional subjects better than others. Requiring either Physics or Chemistry and not both is a convenience to the college, so that either Physics or Chemistry can be given in the Freshman year to those students who do not present one or the other for entrance.

What is lacking in this educational scheme for a high-school curriculum? It leaves out Latin and Greek, but these are no longer required by any engineering college and they are not required in the Science courses of the Liberal Arts colleges in many universities. Two years of Latin is of course a desirable acquisition for any student, but it is not as essential to an engineering student as is one of the seven groups of studies in the list above given. It leaves out Mental Philosophy, Metaphysics, Ethics, Political Economy and similar studies which may be desirable acquirements, but they are no longer considered as necessary parts of a liberal education in most colleges. It leaves out Civics; Civil Government and the Constitution of the United States, but all of these may be included under the general study of Advanced United States History and enough time may be given to them in the History course to insure that no student is entirely ignorant of them when he leaves the high school. It leaves out everything in relation to Fine Arts, but a little elementary

*A paper presented before Section D of the American Association for Advancement of Science, at Philadelphia, Pa., December, 1904.

†Professor of Mechanical Engineering and Dean of the School of Applied Science, University of Syracuse, Syracuse, N. Y.

instruction in the graphic arts can be given in connection with the course in Drawing. This is strongly to be recommended. It leaves out Elocution, but this should be included in the English course. It is highly desirable that in the three or four years of the high-school course, during all of which some English should be taught, attention should be paid to spelling, not only to make the student a good speller, but to cultivate his observing faculty; to penmanship, not to make him a good penman, but to correct slovenly habits of writing; to reading and elocution, not to make him an orator, but to enable him to confront a class and make a satisfactory recitation when he knows his lesson, an accomplishment which is often not possessed by many otherwise good students.

The study of this subject has led to a brief review of what has been written on it in recent years by members of the Society for the Promotion of Engineering Education. I find, in looking over the volumes of the proceedings of this society dating back to 1894, that the subjects of the seven groups above mentioned do not differ essentially from those recommended by several writers in that society or by the committee on entrance requirements which reported on the subject (Vol. III). But in none of these writings does it appear that attention has been given to the desirability of dividing the required subjects into the groups above named and insisting upon the presentation of subjects in as many as seven groups and not allowing a subject in one group to be offered as an option instead of a required subject in another group. This is the particular feature of the proposed entrance requirements on which discussion is especially requested.

The following is a brief abstract from the writings above referred to, together with some notes of comment where they seem to be needed:

Professor Marvin's Preferred Requirements.—Proceedings, S. P. E. E., Vol. II.

Mathematics, Algebra through Quadratics, Ratio and Proportion, Logarithms, Plane and Solid Geometry, Plane Trigonometry. These would be followed in the Freshman year by Higher Algebra and a rapid review of Plane Trigonometry.

[Would it not be better to let Higher Algebra be given in the high school and to omit Plane Trigonometry, which may be given in the first half of the Freshman year in the engineering college with a view to its use in engineering, while in the high school it would only be given as a branch of abstract mathematics?—W. K.]

In Science, Physical Geography, Physiology, Elementary Botany, Physics and Chemistry are the subjects desired. The three last named should be taught in the high school by the laboratory method. Botany is chosen rather than Zoology because of the greater facility with which laboratory material can be secured and because of the more general interest in it. Physics and Chemistry should each be carried through a year with the equivalent of five exercises per week, at least one-half of the time being given to laboratory work. Entrance examinations in Botany, Physics and Chemistry should include the presentation of certified note books showing laboratory examination of thirty or forty plants or flowers, forty experiments in Physics, and sixty or more experiments in Chemistry.

[If all five of the subjects named above are required it is not to be expected that they can all be given in a satisfactory manner. It would appear to be better to require only two subjects, either Physics or Chemistry and either Physical Geography, Geology, Botany or Zoology, one year of each. Half a year each of Physical Geography and Geology may be accepted instead of a year of each and half a year of Botany and Zoology instead of a year of each.—W. K.]

In History, high-school courses should include: History of Greece and Rome or General History, English History and Civil Government. United States History is assumed as belonging to the work of the common school.

[The histories of Greece and Rome lie at the foundation of civilized history and they should be required in all cases. United States History should be assumed as belonging to the work of the common school, but six months in Advanced United States History should be given in the high school, and it may include a brief treatment of the United States Constitution and Civil Government.—W. K.]

Drawing is properly an entrance requirement, and the examination should include a test of the ability of the applicant to make a quick sketch showing the degree of his mastery of the art as a means of expression. Throughout the preparatory course, Drawing should be taught as a language and should be kept in constant use in connection with Geometry, the Sciences and History. The old method of servile copying from a flat for the purpose of making a pretty picture is of no value and should find no place in the schools.

[A little copying from the flat is useful at the beginning of a course in Drawing to give the student correct habits in the drawing of lines.—W. K.]

In English, the entrance examination should pre-suppose a most thorough training, not only in grammar and elementary composition, but also in Elementary Rhetoric and in rapid and forcible use of the mother tongue. It should also require a considerable knowledge of the classics of English Literature. . . . . The so-called History of English Literature as found in the usual manual should find no place in the high-school course or entrance examination. The ability to write good English should be determined not only from the formal English examination but also from papers presented in other subjects. The combination of a passing grade in English with execrable English in other papers is no rarity in the September of every year.

[This statement is good as far as it goes but much more might be added. The present method of teaching English in the primary, grammar and high schools results in most atrocious spelling, carelessness in the use of words, poor framing of sentences and lack of logical arrangement in composition. The evil probably begins in the primary school where the pupils are not taught to see the letters which form a word, but are led by the so-called "sight reading" to take a word as a whole and neglect both its spelling and derivation. Something ought to be done by the engineering schools to get rid of the New England requirements for reading. It is safe to say that not one boy in ten gets any value out of the Sir Roger De Coverley Papers and not one in fifty out of Carlyle's Essay on Burns.—W. K.]

In foreign language work there should be required both French and German to the amount equivalent to two years' work in each with three or four exercises per week. The entrance examinations in French and German should include the main facts of grammar, but should be largely directed to a test of the student's ability to read and translate ordinary prose at sight.

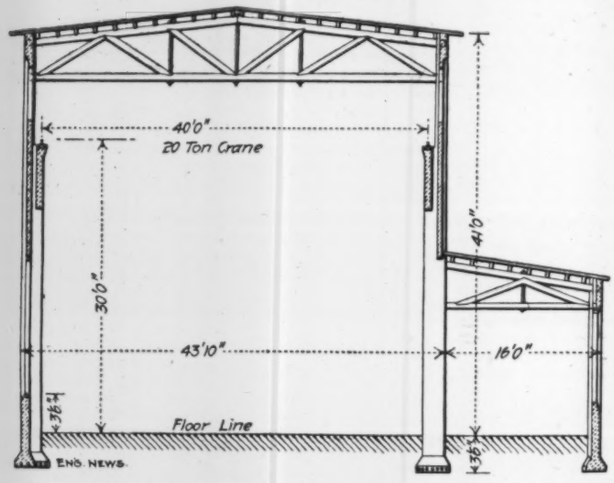
[This is good, but is it not asking too much? If we require both French and German from the high school, together with all the other desirable requirements, it will result in either lengthening the high-school course to five years or else in giving some of the studies too short a time. Should not Spanish be taken as an equivalent of French? The technical colleges are getting many students from Spanish speaking countries and in the future we may expect that many American technical graduates will be sent to Spanish speaking countries.—W. K.]

The high-school course cannot be technical. Its office is to give special training and culture and that too at a time when the strongest impressions are made. The Mathematics, the Drawing, the Physics and the Chemistry are essentials for subsequent technical study. The literature, the languages and the history are equally essential to the engineer as a man among men.

From Circular of Committee on Entrance Requirements. Proceedings S. P. E. E., Vol. II., p. 37.

The committee regards preparation for scientific or other colleges as an essentially secondary function of the great body of high schools of the country, and believes that entrance requirements should be, so far as necessary, adapted to the capacity of any high school of thorough methods and high standards.

[It is submitted that the high school studies in each of the seven groups are all culture and not technical studies; that some study in each group is necessary to a broadly educated man; and that they are not beyond the capacity of any really good high school. Do they not form the basis of a desirable curriculum for all high school boys, including the 80 per cent. or more who do not go to college? For those who do not go to an engineering college some additions to the list of studies should be made, viz., for those intending to go to a college of Liberal Arts, add Latin; for those who do not go to college, give both physics and chemistry; for those who expect to follow mechanical pursuits, give advanced manual training; for those who expect to go into business, give bookkeeping and stenography.—W. K.]



Section of Building through Windows.

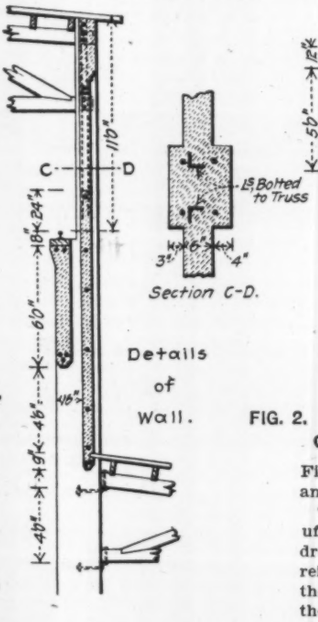


FIG. 1. ERECTING SHOP AND CRANE GIRDERS OF REINFORCED CONCRETE.

AN ERECTING SHOP AND CRANE GIRDERS OF REINFORCED CONCRETE.

A paper prepared for the annual meeting of the Illinois Society of Engineers and Surveyors briefly describes a factory building in which the girders for the traveling crane are of reinforced concrete.

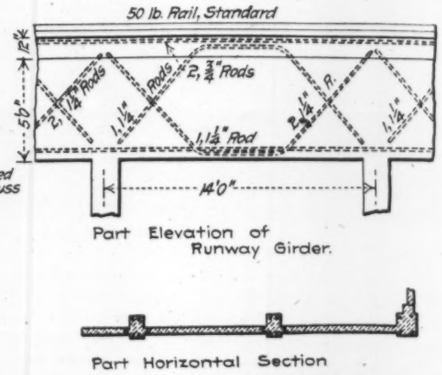


FIG. 2. DETAILS OF ERECTING SHOP AND CRANE GIRDERS OF REINFORCED CONCRETE.

Figs. 1 and 2 show the design of the building and the crane girders.

The building is an erecting shop for a firm manufacturing heavy machinery. The plans were drawn for a structure of brick and wood and the reinforced concrete construction was adapted to these plans. The building is 200 × 60 ft., 45 ft. of the width being used for erecting purposes, and 15 ft. for a bench shed where all fitting is done. The traveling crane is of 20 tons capacity and weighs about 21 tons. To distribute the vibrations and shocks due to the movement of the crane when handling its load, the roof trusses were made deeper than would otherwise be necessary, and fastened to angle irons which extended down in each column to about 2 ft. below the upper windows. Horizontal rods were passed through these angle irons, above and below the windows, and connected up by means of large sleeve nuts; these extend throughout the length of the concrete walls, thus tieing the whole structure together.

A NEW RULE GOVERNING ELEVATOR SAFETIES FOR NEW YORK CITY.

As many of our readers know, the present conditions surrounding the installation and use of elevators are far from satisfactory. Frequent accidents in the last few years have repeatedly drawn attention to the subject. In New York City there is, perhaps, more urgent need of improvement than elsewhere, partly because of the great number of elevators in use and the extreme range of the service for which elevators are used, and partly because a large proportion of the total number of elevators is primitive or antiquated in type. The fact that so large an area of the city is built up solid, and that New York City has most of its factories located in loft or warehouse

buildings in crowded districts, makes necessary additional care in the supervision of their construction and operation. However, a recognition of the need for thorough supervision of elevators has come but recently. The fashion has been to rely almost wholly on the self-interest of elevator builders and operators, and elevator insurance companies where these are concerned.

A new regulation governing the installation and maintenance of elevator safety devices in the Borough of Manhattan, New York City, marks a distinct step forward in this matter. The text of the regulation is here reproduced.

RULES FOR ELEVATOR SAFETIES.

(Adopted by the Bureau of Buildings, of the Borough of Manhattan, New York City, on Jan. 5, 1905.)

All elevators now in use and hereafter installed in any building in the Borough of Manhattan shall have a governor or speed regulator, suitably connected with a safety device on the car, whereby upon excess of normal speed the governor dog grips and positively stops the governor rope, with no injury to the rope, and whereby the stopping of the safety rope brings the gripping jaws on the car when said jaws are set at a running clearance of at least ¼-in. from each face of each rail, in contact with the rails in not over 1½ ft. distance of car travel after the safety rope is stopped, and whereby the further travel of the car up to a distance of about 8 ft., with a heavy load at high speed, gradually increases the pressure of the jaws on the rails, independently of any stretch of the safety rope or of the yielding of any positive mechanism of the safety device, thereby bringing any load at any speed to a safe and easy stop. The governor or speed regulator shall be set to operate at from 10 to 50% above the running speed of the car and the governor or regulator shall be plainly marked at the speed it is to operate at. Said safety device to provide positive and ample power to stop any load that the car can lift and to operate as heretofore specified, independently of any wear or adjustment of any part of the safety device. All speed governors must have adjustment to allow them to operate at normal car speed for testing and inspection.

The Bureau has sent copies of this rule to all manufacturers of elevators, accompanied by a letter in which reference is made to the paper on "Passenger Elevators" read before the recent International Engineering Congress by Mr. Thos. E. Brown, M. Am. Soc. C. E. The letter endorses the recommendations made in this paper regarding elevator safeties and calls upon all owners, architects, builders and manufacturers to cooperate with the Bureau in carrying into effect the ideas expressed there and in the rule above reprinted.

As the remarks on elevator safety devices in Mr. Brown's paper give an excellent statement on the scope and methods of this branch of elevator work, they are presented in an abstract printed below. While they were intended to apply specifically to passenger elevators, they should in general be taken to apply equally to elevators designed for freight service.

ELEVATOR SAFETY.*

By Thos. E. Brown,† M. Am. Soc. C. E.

The safety of passenger elevators is of the highest importance, and, while elevator builders have given great attention to the improvement of the efficiency of elevator plants, the essential element, safety, has not been lost sight of.

In the early days of slow speed the danger of fall from breakage of the cables was alone considered, and the devices used were principally such as would stop the descent of the car should the cables break; but with the introduction of higher speeds, necessitating better designed apparatus, and the use of a multiplicity of cables, accidents due to breakage of cables became infrequent, but, nevertheless, it was found that serious accidents could occur, and did occur, from runaways caused by derangements of the controlling apparatus, loss of pressure, etc., and it was recognized that safety apparatus depending on velocity and not alone upon breakage was necessary.

The two essential elements of safety are the prevention of excessive speed from any cause, and overrunning the limits of travel.

The early forms of safeties were designed to produce positive and quick stops. These answered for the slow speeds then in use, as, with such speeds, short stops were not dangerous to the passengers; but with the high speeds usual to-day, namely, 8, 10 and 12 ft. per sec., such devices, even if they could withstand the impact without their own destruction would result in serious injury to the passengers. Hence modern safety devices provide invariably for a resistance proportioned so that the car will slide a distance proportional to its velocity. Tests have shown that a strong, healthy person, when descending at speed, may be stopped in a distance of one-fifth of the velocity height without serious injury. This means increasing the strains upon the members of the body to six times the normal strains due to the individual's own weight. Manifestly, persons of delicate structure could not stand such a strain without serious injury, and in good elevator practice, it is customary to arrange the safety devices to produce a stop about equal to the velocity height, thus doubling the strains on the members of the body, strains which a person of the most ordinary physique can sustain without injury of serious discomfort.

To accomplish this, the retarding force of the safety devices should not exceed twice the weight of the car and load. The arrangements by which the safeties were operated by breakage of the cables are now generally abandoned, and modern devices are operated by speed governors set for a predetermined speed, usually from 30 to 50% in excess of the designed speed of the elevator. If, from any cause, the speed of the car reaches that at which the governor is set, the safety devices are put in action and the car brought to rest.

All the governors are of the centrifugal type, and are usually set in a fixed position at the top of the hatchway, and revolved by a rope attached to the safety devices on the car, the governor acting by gripping the rope and preventing its further motion, the continued motion of the car operating the safety clutches. In some cases the governor is placed upon and carried with the car, and operates the safeties directly, the motion being imparted to the governor by a standing cable. In either case the principle of action is the same.

In 1893 the guide rails of elevators were principally of hard wood, and the safety clutches were designed to act upon these. The type of safety generally used consisted of arrangements of planer teeth forced into the guide and producing resistance by planing or grooving the wood guide as the car descended. These devices in various forms are still in use with wood guide strips, especially for very heavy work, and for light work where the use of wooden guides is not considered objectionable.

For the modern office building, and with high-class passenger elevators generally, where the loads carried do not exceed 3,000 or 4,000 lbs., steel T-guides are used on account of the superior, smooth, gliding motion attained when such guides are well finished and well erected.

The safety device used with such guides invariably consists of heavy jaws caused to grip the guides with sufficient force to produce the friction required for retardation. As the coefficient of friction on a greased steel guide is at times as low as 0.08, it will be evident that such jaws must grip the guides with tremendous pressure. This is accomplished by constructing the jaws in the form of scissors, the handle ends being forced apart by wedges, acted upon either directly by steel springs or by right and left hand screws, turned by a drum upon which the governor rope is wound. The first method gives a uniform pressure (that due to the force of the spring) and therefore uniform retardation. The second gives a varying pressure, gradually increasing as the safety drum turns and with increasing retardation. Both methods have advantages. A safety device combining both methods, the jaws being actuated primarily by a spring, the pressure upon which is increased gradually by screws actuated by the revolving drum is sometimes used. These safeties, as designed for standard passenger elevator service, have a retarding force of from 8,000 to 12,000 lbs.

The ordinary hydraulic elevator (which descends by gravity) is not likely to acquire dangerous speed in an upward direction, and hence the governors and safety devices are designed to act in descending only. The electric drum overbalanced elevator, also, under general conditions of design, is not likely to ascend at excessive speed, and, therefore, is provided with safeties acting on descent only; but such types as the pulling plunger hydraulic and all forms of electric rope-driven elevators may acquire excessive speed in either direction, and hence are provided with double-acting governors, arranged to operate the safeties in either direction.

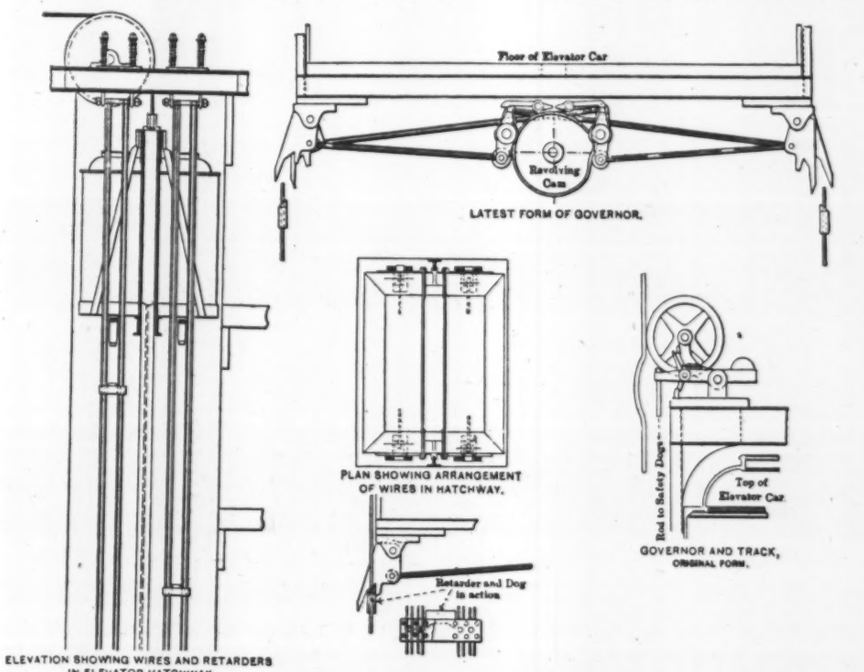
Overrunning the limits of travel is provided against in hydraulic elevators by the introduction of a secondary valve, which is closed by the motion of the piston or cross-head at each end of its travel; also, the stroke of the piston is limited by the length of the cylinder, and the pistons are usually arranged with followers which cover the ports at the ends of the stroke; thus the hydraulic engine has three provisions against overrunning: 1. The secondary valve especially for the purpose; 2. The closing of the ports by the piston followers; and 3. The final limit of the length of the cylinder.

With the electric drum machine, the limit stop consists of a mechanical device attached to the winding drum which operates the same controlling devices at the limits of the travel as are used in ordinarily stopping the machine. The mechanical connection to the drum usually consists of a fine-threaded screw on the end of the drum shaft upon which a traveling nut moves in a fixed ratio to the movement of the car; this nut, at the ends of its travel, moving the controlling devices. Such a device, being adjustable and operating the ordinary controlling devices, fails if the controlling devices fail, or if improperly adjusted. Hence additional limit switches are placed in the hatchway, operated directly by the car itself, or its counterweight. Should the car run beyond its limits, these switches cut off the current and apply the brake.

In all types of rope-drive elevators, as the ropes are not connected positively to the driving sheaves, there is no fixed relation between the position of the car and the position of the driving machinery; hence mechanical connections from the driving sheave to the controlling devices cannot be positive. In such cases, limit switches, impinged upon by the car or counterweight, and which operate the ordinary controlling devices, are used, and, in addition to these, pneumatic or hydraulic buffers are attached to the counterweights or cars, arranged to bring them to rest at the ends of the travel independently of other devices. This method is particularly applicable to rope-drive machines, as, there being no positive connection between the cars and driving sheaves, the winding mechanism can be allowed to continue running by slippage of the ropes.

An important element of safety in all types of elevators is that the counterweight be arranged to bottom solidly before the car reaches the overhead work.

Besides these primary safety devices, secondary devices are used with drum-winding machines, such as potential switches to cut off the current in case of excess, and slack cable switches to cut off the current and prevent further revolution should the car or counterweight be arrested in


Floor of Elevator Car
Revolving Cam
LATEST FORM OF GOVERNOR.
PLAN SHOWING ARRANGEMENT OF WIRES IN HATCHWAY.
Top of Elevator Car
Rod to Safety Dogs
GOVERNOR AND TRACK, ORIGINAL FORM.
Retarder and Dog in action
ELEVATION SHOWING WIRES AND RETARDERS IN ELEVATOR HATCHWAY.

THE CRUICKSHANK ELEVATOR SAFETY.

*An extract from a paper on "Passenger Elevators," read before the International Engineering Congress at St. Louis, Mo., October, 1904.

†Consulting Engineer, Otis Elevator Co., New York City.

its travel either by the regular safety devices or by obstructions in the shaft, thus preventing the cable unwinding from the drum. Manifestly, such slack cable devices are not required with hydraulic elevators and rope-drive electric elevators, as in these types the cables are always in tension. In the modern types of electric elevators, the brakes are held off by magnets excited by the current, and hence breaking of the current by means of any of the safety attachments actuates the brakes.

It is customary to arrange elevator safeties, which are essentially automatic, so that they may also be put in action by the operator in the car.

All the foregoing provisions for safety, while very efficient when maintained under proper supervision, being mechanical and electrical devices, are not proof against inattention, carelessness and neglect. They may be relied upon absolutely when new and first adjusted, and afterward, if cared for properly; but, unfortunately, they are rarely called upon until after long use, inviting a false sense of security and neglect. Hence, when, after a long period of service, they are called into action unexpectedly, have frequently failed from neglect or adjustment, and even from previous breakage or removal of essential parts. These conditions caused considerable study to be devoted to an effort to devise some type of apparatus which would be free from danger of becoming inoperative through neglect, and led to the production of what is known as the "Cruikshank Elevator Safety," the invention of Mr. R. C. Smith. This is shown in Fig. 1 herewith. Previous devices required to be kept in good condition in order to act; this requires to be kept in good condition to keep it from acting and preventing operation of the elevator.

It is based upon the principle that if a wire is bent over three pins, force is required to slide the pins along the wire, the resistance being nearly inversely proportional to the cube of the distance between the pins.

For passenger elevators the standard size of wire used is 0.192 in. in diameter, having a breaking strain of 1,800 lbs. The pins are spaced so as to give a resistance of 400 lbs. per wire, or a safety factor of 4.5. Four sets of wires, eight in a set, are stretched from top to bottom of the building at the sides of the elevator guide rails. Plates with bending pins inserted, called "Retarders," are strung along the sets of wires at intervals, usually 10 or 12 ft. Four hinged dogs are attached to the bottom of the car, one for each set of wires, and are normally in position over the retarders. In normal running, as the car passes the retarders, the dogs are allowed to drop back out of the way and pass without catching. The dogs are arranged in pairs, and the retarders are staggered, and one pair of dogs only can move out of the way at a time, leaving the others in position over the retarders.

A governor wheel is attached to the top of the car by a pivoted arm. This governor wheel runs on a track with depressions at intervals, into which the governor wheel drops, its motion causing the dogs to swing and pass the retarders. The depressions in the tracks are of such length and depth with relation to the pendulum length of the governor that when traveling at normal speed the governor follows the track, but at a higher speed than normal, the governor fails to follow the curve of the track, and fails to move the dogs out of the way of the retarders and the elevator car is brought to rest with uniform retardation.

When one pair of dogs picks up the retarders, the retarding force is that due to 16 wires, or 6,400 lbs., and if this resistance is not sufficient to bring the car to rest, it continues to slide until the other pair of dogs picks up the retarders on the other sets of wires, producing a total retarding force of 12,800 lbs.

The strain in the wires is well within the elastic limit, and may be brought upon the wires an indefinite number of times without injury.

After the safety has been in action, the retarder can be slipped back and reset in position easily and quickly.

It will be readily seen that with this system the safety can be prevented from stopping the car, even at normal speed, only by being maintained in good working order.

In the later form of this device the governor and rail are replaced by a cam under the car, revolved by a cable, depressions in the cam performing the function of the depressions in the rails. In this case the pendulum length of the dogs themselves is the governing function, as they swing out of the way of the retarders by gravity, and hence if the velocity is too great, the dogs cannot clear the retarders, and the car is stopped.

Latches which prevent the dogs swinging back, once they have swung out beyond a given distance, form a second governing device, as, while the time of swing is fixed by the pendulum length, the length of the swing increases with the velocity of the car.

This device may also be used as an automatic terminal stop by placing retarders at the terminals, rendering it impossible for the elevator cage to go beyond its limits without catching on the wires. Also, the governor track may be arranged so that the car cannot approach either terminal except at slow speed.

An important feature of this device is that when the car is arrested, it can be immediately released by reversing its motion, provided the cables and machinery are intact, and the power has not failed.

This type of safety is comparatively new, but, on account of its intrinsic merit, is coming rapidly into use, and bids fair to become the standard elevator safety device. It is estimated that the number of passengers carried daily by elevators in the City of New York exceeds the number carried by all the surface and elevated railways, and it speaks well for the excellence and safety of these machines that so few of these millions of passengers are injured.

THE SUSPENSION BRIDGE FAILURE AT CHARLESTON, WEST VIRGINIA.*

By Addison M. Scott,† M. Am. Soc. C. E.

On December 15, 1904, at 8.15 a. m., an old suspension highway bridge across Elk River at Charleston, W. Va., gave way and four school girls and five teams with their drivers fell to and through the ice (which was about 2½ ins. thick) into the river. Several other pedestrians, from eight to ten perhaps, were on the bridge at the time, but were near enough to the ends to run off or be dropped to the ground between the shores and the tops of the banks. The accident resulted in two deaths, Miss Wray Humphreys and Mamie Higginbotham, aged 15 and 13 years, respectively (who were either instantly killed by the fall or drowned), and the serious injury of six other persons. At present it is thought all of the injured will recover. Eight horses (three double and two single teams) fell into the river, only one of which was gotton out alive. The height from the floor of the bridge to the ice, in the center of the span, was about 35 ft. The water under the bridge was from 8 to 10 ft. deep. The distance across from shore to shore was about 300 feet. Considering all the circumstances, it is remarkable that the fatalities were not greater. The site is about a half mile above where Elk River joins the Great Kanawha. Movable Dam No. 6 on the Kanawha, four miles below, was up, and slacked the water in this part of the Elk, so there was scercely any current at the bridge.

FIG. 1. VIEW OF WRECKED SUSPENSION BRIDGE OVER ELK RIVER, AT CHARLESTON, W. VA.; VIEW FROM CHARLESTON END, LOOKING TOWARD WEST CHARLESTON.

The accompanying view, Fig. 1, was taken an hour or so after the fall of the bridge.

DESCRIPTION OF BRIDGE.—The bridge was built in 1851-2 by a company of citizens assisted by the State of Virginia. During the Civil War it was twice disabled by retreating armies, the last time being completely wrecked. It was a toll bridge up to 1886 when the county bought it and made it free. After January, 1895, it was practically in the hands of the City of Charleston. More of the history of the bridge will be given below.

As a bridge it was rather a primitive affair, and though it has been partly rebuilt several times, no material change had been made in the plan. The old cables and anchorage were in use when the bridge fell. It was 478 ft. long between centers of its well-built and still well-preserved masonry towers. It was carried by four wire cables, each about 3¼ ins. in diameter, two cables on a side.

The width of roadway was 17 ft. There was no sidewalk. The floor beams, 4 × 12 ins., 19 ft. long, and spaced 4 ft. apart, were held by ¾-in. diam. wire-rope suspenders, one at each end. To these vertical (except as cradled) suspenders a light hand-rail was wired. The bridge had no truss system or guys whatever, and of course vibrated a good deal under any kind of a load. The towers of the bridge are 30 ft. in height above the roadway—much lower for the span than governs modern practice—and in a transverse direction are 30 ft. apart between centers. The bridge floor was 6 ft. 4 ins. higher at one end than at the other (the Charleston side being the lower) to suit the difference in elevation of the banks.

PLACE OF FAILURE.—The initial failure was at the up-stream anchorage on the Charleston side where both cables gave way, one of them parting inside the anchor pier and the other being pulled out of the masonry with the top link, or first section, of the anchor irons attached. The failure of these two cables let the upper side of the bridge drop, which threw so much load on the down-stream cables that one of them was pulled in two inside the anchorage on the West Charleston end. This released the suspender yokes on that side and the entire floor went down into the river or on the banks. Nearly all of it that fell into the river was turned bottom side up. This leaves but one cable of the structure in place across the stream.

As stated above, one of the cables pulled a section of the anchor irons out of the masonry. This double link, 4½ ft. long, was made of 1⅛-in. square iron, two concentric pieces on each side, connected at the upper end by a 2¼-in. diameter bolt, 7½ ins. long between head and nut, that held the cast shoe, or bearing, for the end of the cable. The wires of the cable were divided at the end to form a loop-eye that went around the shoe. With the link that was pulled out came a 2¼-in. diameter bolt that made the connection with the next section of the anchor irons, and a 6-ft. piece of 1⅝ × 2-in. iron, badly bent. The bar was no doubt run through the link to improve its grip in the masonry. The lower end connection bolt was broken; the fra-

*See also a brief report on the accident, with sketches of parts of the construction, in Engineering News of Jan. 5, 1905, p. 10.

†Charleston-Kanawha, W. Va.

ture looks like an old one and shows bad crystallization. A large part of the fracture on one piece of the broken bolt is smooth from what looks like the effect of a recent blow or of being scraped; this is probably due to contact with another iron when it was jerked out. It is evident that this bolt was not sheared in two. (No one here knows anything definite, at present, about the plan of the anchor irons, except as shown by the section that was pulled out.) The companion cable in the same pier, which was pulled in two, evidently parted at the end loop. The wires of the broken part are all more or less eaten with rust and many of them are almost entirely consumed. Fig. 2, a photograph of some pieces of the original No. 10 wire taken from the cable end, illustrates this.

Each cable had 300 "No. 10 best charcoal wrought, Missouri iron wire," (to quote from the old minutes). The Birmingham gage is evidently referred to. The full sized wire is a fraction over ⅛-in. in diameter. The size of the cables as before stated, was about 3¼ ins. in diameter. It will never be known which gave way first, the anchorage of the one cable or the wire at the loop-eye of the other. The breaking strength of the cable when new must have been at least 300,000 lbs., and the 2¼-in. anchor bolts (the same size connection bolts were probably used in all the anchorages) were decidedly too small for the place. But considering the bad condition of the ends of the cables, with the fact that two of them did break and apparently leave the anchor irons intact, leaves unanswered the question of initial failure as between the two. The wires in the cables, except the ends covered with masonry, appear to be in good condition and it is probable they are, everywhere, about as strong as when new, except inside the anchor piers. These covered ends, judging from the three that are pulled out, and considering the conditions, are no doubt all badly rusted. When the bridge was built, and up to the time the county bought it in 1886, the eye-ends of the cables were outside of the anchor piers, and were kept housed and painted. Soon after the county got the bridge the mistake was made of extending the anchor piers towards the river (with a poor quality of concrete faced with masonry) and covering the ends of the cables. No provision was made to keep water from following the cables into the anchorage. There is not much doubt but that nearly all, if not all, of the deterioration at the ends of the cables has taken place since they were covered up.

LOAD, CONDITION OF BRIDGE, ETC.—The extraneous load on the bridge when it failed is estimated at about 30 tons; about half of this was snow and ice, the greater part of which had been on the roadway for several days, no effort having been made to clear it off. The three double teams that went down had heavy wagons, each loaded with a full yard and a half of damp sand. The bridge had, no doubt, often sustained much heavier loads. It has had unusually hard service during the last few months, owing to greatly increased general travel, and the hauling of large quantities of heavy materials—sand, stone, brick, etc., largely for street paving and the building of a large manufacturing plant (The Kelly Axe and Scythe Factory) on the West Charleston side. During late years, in fact, since the city took charge of the bridge, no guard or attendant has been kept there and no effort whatever made to regulate traffic on it. It has often, notably during the last few months, been nearly covered, not to say crowded, with teams and foot passengers; this too, in spite of the fact that the bridge has for years been considered unsafe for anything but light loads.

The recent bad condition of the floor probably hastened the destruction of the bridge. Lately the floor plank had become badly worn and repairs were made by simply nailing separate strips of one-inch boards over the worst cracks and weak places. This made the surface of the roadway much like a corduroy road, and the increased jar and jerk so caused under the recent heavy traffic, must have severely tried the old cables, especially at their weak points, the anchorages.

RESPONSIBILITY.—Altogether, the story makes a sad case of municipal mismanagement and neglect. The public should be charged up too, with a considerable share of the blame. Many citizens here (outside the officials whose duty it was to attend to it) the writer among the number, have known for years that the bridge was decidedly inadequate for the traffic; they knew too that it was being badly neglected and misused, but no one troubled himself to make any real protest, all appearing satisfied to take the chances when they crossed the bridge and let the question alone.

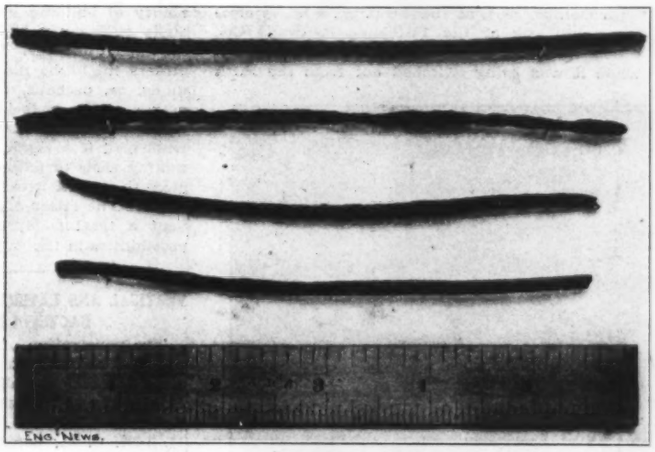


FIG. 2. PHOTOGRAPH OF SOME PIECES OF THE ORIGINAL NO. 10 WIRE, TAKEN FROM THE BROKEN CABLE END.
(Scale: 2-3 full size.)

It should be stated here that at the time the bridge fell the city was asking for and had already received some bids or propositions with a view to having it strengthened and repaired.

HISTORY.—The old bridge had a varied and rather interesting history, an outline of which was given above. It was built in 1851-2 by an incorporated company of citizens of Kanawha County at a cost of about $19,000. The state of Virginia, by its Board of Public Works, took $6,000 of the stock.

The plans were furnished by W. O. Buchanan, a civil engineer from the North (perhaps from Canada), who also superintended its construction up to July, 1852, when he resigned and Wm. Kuhn and Abraham Wright were chosen to look after the completion of the bridge. The contractor for the masonry was Gebbert Mead. The wire and anchor irons were furnished by E. C. Dewey of Wheeling, at the following prices, delivered on the wharf at Wheeling: No. 10 wire at 7½ cents; No. 16 at 14 cents; No. 24 at 20 cents per pound; links and bolts at 7½ cents; and castings at 3¼ cents. The wire was "to be made of best charcoal wrought, Missouri iron, in as long strands as possible." The wire was shipped to Charleston by boat and the cables made on a platform in the street near the bridge, under direction of John Downey. The No. 10 wire was laid straight and the cable wrapped every 12 or 15 inches with a band, from 3 to 4 inches wide, of small wire.

In July, 1861, soon after the battle of Scary, which was fought July 17, the Confederate General Henry A. Wise retreated south out of the valley. At this time the Confederates partly cut one of the cables and burned a small part of the floor of the bridge, all on the Charleston side. The valley was then occupied by the United States forces under Gen. J. D. Cox, by whose order the bridge was thoroughly repaired, the injured cable being spliced with telegraph wire from the tower to the anchorage, and a new floor, etc., put on. This work was done under the direction of Mr. Solomon Minsker, then and still a valued citizen and an excellent mechanic of the city. Soon after these repairs were completed, the "record rise" of Sept., 1861, in the Elk and Kanawha Rivers, (46.80 ft. above low water at Charleston) severely tried and somewhat injured the bridge by bringing against it great quantities of heavy drift. The bridge has been more or less injured several times since then in the same way by high water.

On Sept. 13, 1862, the tables were turned and the United States troops under Gen. Lightburn made a hasty retreat towards the Ohio, followed by the Confederate Gen. Loring, with a superior force. Lightburn cut one of the cables of the bridge on the North, or West, Charleston side, which completely wrecked it. No attempt was made to repair or use the bridge after this until the close of the war. In the fall of 1865 the bridge was rebuilt by the reorganized company, the State relinquishing its right in it. The old cables were used, the one that was cut by Lightburn being spliced with new wire between the tower and anchorage. Mr. Joseph Bibby owned a majority of the stock and managed the bridge after the war up to the time it was sold to the county in 1886. In February, 1895, West Charleston was annexed to Charleston, after which date the bridge was virtually in the hands of the city.

THE SEWERAGE AND DRAINAGE SYSTEMS OF WHEATON, ILL.*

By Wm. B. Ewing,† M. Am. Soc. C. E.

The city of Wheaton covers an area of about 4 sq. miles and has a population of 3,000. The absence of any defined system of sewerage or drainage has been felt for some time, and Mr. W. H. Tarrant (while City Engineer of Champaign) was engaged to prepare plans and specifications for complete systems of sewerage and drainage, with a septic tank. These have recently been completed. The sewerage system includes 60,381 ft. of trench, 2 to 18 ft. deep, with 8, 10 and 15-in. pipe, 28 flush-tanks, 94 manholes, 40 lampholes, and the septic tank. The drains comprise 55,242 ft. of trench 2 to 14 ft. deep, with 6-in. to 33-in. pipe, 103 manholes and a concrete outlet. Owing to the depth of the sewers and drains below the surface of the ground, the Ys are extended by 6-in. pipe to within 5 ft. of the surface; this required 1,106 ft. of pipe in the sewerage system. Strips of land across various properties were purchased for laying pipe.

The writer's connection with the above began with the spreading of the special assessment. It was an interesting problem to meet the legal requirements of a fair and impartial assessment on account of a large number of irregularly shaped pieces of property lying in the assessed district. It was found on examination that the greatest of any one kind or shape of property was a lot 66 ft. front by 132 ft. deep. In making up the assessments this was taken as a basis and called 66 units. A lot measuring 66 × 166 ft. was assessed a proportionate number of units and one 66 × 198 ft. a still greater number of units. This was the basis of the assessment on the property immediately fronting on the line of the improvements. Property not immediately touching the proposed improvements but lying in the district, was assessed that proportion of the full assessment determined by the difference between the cost of such additional improvements as would be necessary to place the property directly in connection with the present system and the assessment of the same or similar property adjacent to the improvement.

This same principle was adhered to throughout the entire assessment for determining the units for each piece of property. The rate per unit was then the quotient of entire amount assessed, divided by the sum of all the units, which rate multiplied by the number of units assessed to each piece of property determined the amount of the assessment in dollars and cents. This arrangement was found to be very satisfactory, and stood the test of a number of objectors, who appeared in court to seek in some manner to reduce their assessment. The assessment rate stood firm under the repeated attacks of the objectors, who were not very great in number but quite determined.

The prices at the letting varied considerably. The contract for sewers was awarded to the lowest bidder, J. H. Green & Sons, Appleton, Wis., at the following prices:

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, at Chicago, Jan. 18, 19, 20, 1905.

†Chamber of Commerce Building, Chicago.

Sewer pipe delivered and laid—6-in. pipe, 14 cts.; 8-in., 22.8 cts.; 10-in., 31.7 cts.; 12-in., 41.7 cts.; 15-in., 54 cts. Trenching and back filling—2 to 4-ft. cut, 13 cts.; 4 to 6-ft., 25 cts.; 6 to 8-ft., 33 cts.; 8 to 10-ft., 35 cts.; 10 to 12-ft., 37 cts.; 12 to 14-ft., 39 cts.; 14 to 16 ft., 40 cts.; 16 to 18 ft., 45 cts. Manholes, $50; lampholes, $10; flush-tanks, $60; septic tank, $3,500.

The contract for the drains was let to Charles M. Porter, Maywood, Ill., at the following prices: Sewer pipe delivered and laid—6-in., 20 cts.; 8-in., 19½ cts.; 10-in., 29 cts.; 12-in., 43 cts.; 15-in., 55 cts.; 18-in., 80 cts.; 20-in., $1.01; 24-in., $1.42; 30-in., $2.25; 33-in., $3.25. Trenching and backfilling—2 to 4-ft. cut, 30 cts. 4 to 6-ft., 25 cts.; 6 to 8 ft., 35 cts.; 8 to 10-ft., 60 cts.; 10 to 12-ft., 80 cts.; 12 to 14-ft., $1.10. One outlet abutment, $50; catch basin, $30. This contract was later assigned to Green & Sons, who constructed the entire work.

The septic tank was constructed of concrete. The inlet valves and also the valves leading to the sludge well were 15-in. Coffin shear valves. The weir at the outlet is constructed of 6 × 6-in. angle iron firmly imbedded in concrete.

The specifications for the construction of the drains differed from the ordinary specifications by the omission of cement in the joints, the pipes simply being laid with butt joints without cement; where thin silt or mud was encountered, the joints were filled with oakum loosely caulked.

The work at Wheaton was somewhat remarkable on account of constructing the entire system, both of sewers and drains, in one season. They were constructed under one contract for each, by the same contractor. At one time, in addition to several gangs of workmen, four excavating or trenching machines were employed in this work. One machine, not able to make a showing, was abandoned. Another machine, known as the Dalton machine,* consisted of a wheel about 13 ft. diameter, with six arms extending about a foot beyond the rim of the wheel. To these arms were attached small pieces of ¼-in. steel, about 8 ins. long and 4 ins. wide, for the purpose of cutting loose the earth in the trenches. Immediately following these knives was a heavy iron bucket about 1 ft. square and 14 ins. deep. This bucket followed the knives around through the trench and revolved with the wheel. On reaching the top of the circle the arm to which the bucket was attached was released and the bucket turned out to one side in such a manner as to empty the contents along the side of the trench. The wheel revolved so as to cut toward the machine. The machine was mounted on wheels and pulled the cutting wheel close up to the work, and itself along the line of the trench by means of a cable fastened to a dead-man some distance away and winding around a slowly revolving drum. In 22 miles of work this machine excavated about 30,000 cu. ft. Its average daily rate varied from 250 ft. in hard stony ground to 400 ft. in a trench 7 ft. deep and 20 ins. wide in soft ground.

The other two machines used in this work were known as Austin excavators.† The principle of these was entirely different from the one just described. It mainly consisted of an arm constructed of angle irons thoroughly braced and of sufficient length to reach from the machinery to the bottom of the trench. At the end of this arm was fixed a sprocket wheel and a number of rollers at equal intervals along the arm. A double endless link belt or chain carrying a series of cutters and scrapers extended from a sprocket wheel at the engine down around the end of the leg and back again. Upon lowering the leg to the ground and revolving the belt toward the machine, the cutters loosened the earth, which was drawn up to the top of the trench, by the scrapers back of the knives to a horizontal belt conveyor, running at right angles to the machine, which belt discharged excavated material along the side of the trench. The machine was pulled ahead of the trench by a wire cable fastened to a dead-man of two 6-in. pipes sunk in the ground, and the cable slowly wound on a drum on the machine. This machine was quite successful in excavating, and in heavy work has cut a trench 30 ins. wide and from 15 to 18 ft. in depth. In this trench the average progress per day was from 150 to 200 ft., depending upon how much bracing was necessary. Under lighter work this machine has excavated 750 ft. of trench 30 ins. wide and 7 ft. deep, through a hard clay mixed with small stone.

Most of the back filling was done by team and scrapers. The surplus earth was drawn away in wagons and later the streets were gone over with a road grader. All the pipes were laid to a true line and grade. Before excavating, stakes 25 ft. apart were placed in line about 4 ft. from the center line of the trench and on them was marked the cut below the marks on the stake. From the marks on the stakes, cross pieces were laid horizontally across the trench, and a line was stretched from one cross piece to the next. The line and grade of the sewer or drain were fixed by measuring from grade line.

The sewers were usually placed in the center of the street. The drains were usually 10 ft. north or west of the center line of the street. At each street intersection, the lines of the sewers and drains crossed each other. To avoid confusion and to prevent the sewers and drains from intersecting each other, the sewer grades were first fixed and then transferred to the drain profile, whose grades were then laid so as to pass over or under the sewers.

Work was begun about May 25 and the entire work was completed on Nov. 30, 1904. The contractor's estimates were paid in cash raised by selling special assessment bonds from time to time in amounts varying with the amount of the estimates.

*Engineering News, July 12, 1900.
†Engineering News, Sept. 19, 1901.

AN INSTRUCTIVE BRIDGE ACCIDENT AT PITTSBURG, PENNSYLVANIA.

By Willis Whited,* Assoc. M. Am. Soc. C. E.

On Dec. 29, 1904, at about 8 p. m., a heavy electric street car of the Pittsburg Railways Co., which was out of repair, got beyond control while it was being switched out from the Fifth Ave. line to an unused track on Seneca St. The car ran wild down to Tustin St., took a right angle curve without being derailed, and ran on down a steep grade to Brady St. where there is another right-angle turn. Brady St. runs lengthwise under the north viaduct approach to the South 22d St. Bridge over the Monongahela River. The car coming down Tustin St. at high speed, jumped the track at the corner of Brady St. and struck one of the columns supporting the viaduct, knocking it several feet out of place.

ACCIDENT TO THE SOUTH 22D ST. BRIDGE, AT PITTSBURG, PA.

This column was about 24 ft. high, built of two 15-in. channels, latticed, and had a concrete fender around the base which concealed the anchor bolts. The four anchor bolts of ⅞-in. diameter, were so short that they barely stuck through the base plate, and they therefore had no nuts on. When the car struck the column it bent the channels so as to lift the base clear of the anchor bolts, so that pier and anchor bolts were not injured.

The viaduct is built with a steel trough floor paved with asphalt. The riveted lattice girders carrying it are 32 ft. apart on centers and are about 8 ft. deep. The two spans resting on the broken column were each about 60 ft. long. There is strong portal bracing between the columns and the bottom flanges of the girders are provided with 3 × 3 × 5-16-in. angle lateral bracing.

When the column was knocked out, the girders settled about 32 ins., in which position they jammed against each other and against the adjacent spans in such a way as to prevent their falling farther. As soon as timber shores could be put in to support the girders, which was done that night and the next morning, traffic was resumed on the bridge, although the bridge was not jacked up to its proper height for several days.

The damage done was comparatively trifling. The column had to be reconstructed, a few other pieces were broken and a number were so bent that it was necessary to cut them out to straighten them. Nobody was hurt, however, and the damage was trifling compared with what one would expect from an accident of that kind. The accompanying view of the upper end of the wrecked column gives some idea of the extent of the damage.

Wherever steel viaducts are built over railway or street railway tracks, there is always danger of accident similar to this. A viaduct was knocked down and considerable damage done in the summer of 1903 at Hay's Station, a short distance beyond the city limits of Pittsburg, by a derailed freight train. Such accidents suggest the advisability of building the masonry under such viaducts sufficiently high and substantial to resist the impact of a car. If that is not practicable, the girders might be made continuous over the columns, or, perhaps, they could be connected together at the ends in such a way as to allow a certain amount of settlement of the foundations while yet, if a single column were removed, sustaining their own weight without subjecting any piece to a stress greater than about 25,000 lbs. per sq. in. The latter expedient would suffice to prevent a total collapse of the structure with its possibilities in the way of appalling loss of life.

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VERTICAL AND LATERAL PENETRATION OF SEWAGE BACTERIA INTO CHALK SOIL.

The penetration of sewage bacteria into chalk soil was recently studied at the sewage farm at some barracks on Salisbury Plain, near Amesbury, England, and was made the subject of a paper by Lieut.-Col. A. M. Davies and W. C. Tyndale, M. Inst. C. E., before the congress of the Sanitary Institute at Glasgow last summer.

The barracks are 900 ft. from and about 75 ft. above the Nine Mile River, the subsoil in the vicinity being chalk, with about 1 ft. of earth above it. The slop water, urine, stable drainage and a small amount of water-closet sewage from 1,377 persons and 523 horses, averaging about 42,000 U. S. gallons a day, is applied to land about 525 ft. from the barracks, through a 9-in. channel having outlets every 30 ft. The area irrigated is about four acres, but 14 more are available. The upper layers of the soil are "soft, compact, homogeneous and free from fissures." The underground flow appears to be towards the stream, the level of which is entirely dependent on the water level in the chalk. Of late years the stream has been "practically dry," and at the time of the studies water was found a few inches below the bed of the stream.

On July 22, 1902, samples of water were collected from two holes in the stream bed and four samples of soil were taken from the sewage farm. Both samples of water contained B. coli, but no B. enteritidis sporogenes. The holes were all shallow and were dug below the sewage carrier. Soil from a hole 30 ft. below the carrier showed coli, only; 135 ft. below the carrier, both coli and enteritidis sporogenes; 210 ft. below the carrier, and just beyond the area reached by the sewage, neither germ. About 60 ft. from the carrier in another part of the irrigated field, enteritidis sporogenes but no coli were detected. On Aug. 7, 1902, neither the two kinds of germs named nor streptococci were found in soil from two holes 10 ft. and 50 ft., respectively, from the lowest point to which the sewage flowed.

It having been concluded that sewage bacteria applied to the surface of the land travelled laterally but a short distance a tunnel was driven to study their vertical penetration. The tunnel was started at a point on the slope 150 ft. horizontally from the carrier and driven towards the carrier

60 ft. Its depths below the surface were 4 ft. at the entrance, or 150 ft. from the carrier; 6 ft. midway, or 180 ft. from the carrier; and 9 ft. at its lower end, or 60 ft. from the carrier.

Samples of subsoil taken from the tunnel at the three points indicated on Oct. 14, 1902, after the overlying ground had been receiving sewage for two years, showed no trace of either coli or enteritidis sporogenes, "nor were any gas-forming bacteria found, even in two decigrammes of soil."

For two weeks the sewage was concentrated on the plot of land over the tunnel. Samples of soil were collected on Nov. 25, 1902. Analyses of these and of further samples, as described, are reported in the paper as follows:

At the head of the tunnel (90 ft. from the carrier) and 9 ft. beneath the surface, coliform organisms were found to be present in 1 milligramme of soil; gas-forming organisms were found in 1 centigramme, but not in 1 milligramme: B. enteritidis sporogenes was not found in 1 centigramme. At 6 ft. beneath the surface (but 30 ft. further distant from the sewage carrier) coliform organisms were detected in 1 centigramme, also gas-forming bacteria; neither were found in 1 milligramme. B. enteritidis sporogenes was not detected in 1 centigramme. At 4 ft. beneath the surface (but 30 ft. still further away from the sewage carrier) neither B. coli nor B. enteritidis sporogenes nor gas forming bacteria were found, even in 1 decigramme (except a small number of the last named).

During December and January the sewage water was applied over the whole area in regular rotation, thereby reverting to the usual routine for distribution, and on Feb. 3, 1903, further subsoil samples were taken from the tunnel at same points as before. Coliform organisms were found at the head of the tunnel at a depth of 9 ft. (in 1 centigramme), but no B. enteritidis sporogenes, and no gas-forming bacteria. At 6 ft. depth and 30 ft. further distant a coliform growth was obtained from 1 milligramme, but no B. enteritidis sporogenes, nor gas-forming bacteria (in 1 centigramme). At 4 ft. depth and 30 ft. still further distant no coliform growth, no B. enteritidis sporogenes, and no gas-forming bacteria were found in 1 centigramme. No streptococci were detected in any samples. The subsoil samples were to all appearance clean and sweet and free from any smell of sewage, in every case.

During 1903 the application of foul water to the irrigation area was continued regularly. At the beginning of October, 60 water-closets were brought into use, and the sewage was led through a septic tank (instead of being distributed, as before, over the ground untreated). Subsoil samples were taken from the same points as before, on Dec. 8, 1903. They all appeared to be clean and sweet: no coliform organisms, no B. enteritidis sporogenes, no gas-forming bacteria, and no streptococci were found in any sample, even in 1 decigramme.

In commenting on the analyses the authors say that most of the B. coli found in the soil, as distinguished from the subsoil, might have been due to the cattle and sheep having access to the stream and land, but that the coli found in the soil from near the sewage carrier was probably although not certainly from the sewage. The coli and associated organisms found in the subsoil were probably from the sewage, as was also the B. enteritidis sporogenes from the soil near the carrier. Coliform organisms in four samples were the only bacterial indications of "sewage access to the subsoil."

The final conclusions of the paper are as follows:

(1) That, in the case of a chalk formation, there is practically no lateral movement of fluid falling on or spread over the surface, but that the moisture passes vertically downward. (2) That, so far as our observations extend, the soakage consists of saturation only, and that in the upper portion of the chalk the liquid forms no defined lines of percolation, resulting in trickles even where the surface is deluged. (3) That, when the surface is deluged, traces of sewage, as evidenced by bacteria, may penetrate to a considerable depth, but that when sewage is applied in an ordinary and reasonable way over the surface, no such contamination of the subsoil takes place.

Although having no direct bearing upon the investigations it is interesting to note that the septic tank mentioned above was installed some time before the date of its use there recorded, and that its use was discontinued because of the "offensive smells" produced. These smells were attributed to the large proportion of stable drainage in the sewage.

COMPARISONS OF FULL-SIZED AND SPECIMEN TESTS OF VERY LARGE STEEL EYE-BARS.

In recent bridge-building practice in America, extensive use has been made of very large steel eye-bars. Thus the Thebes bridge across the Mississippi River, the Wabash Ry. bridges at Mingo Junction and Pittsburg, the Quebec bridge across the St. Lawrence, all of which are building or already completed, contain tension members composed of eye-bars up to 14 to 16 ins. wide by 2 ins. in thickness. The plans of former Bridge Commissioner Lindenthal for the Blackwell's Island and the Manhattan bridges over the East River at New York City called for eye-bars up to 18 ins. in width. Special forge plants have been built, one at the Phoenix Iron Co.'s plant at Phoenixville, Pa., another at the American Bridge Co.'s new plant at Ambridge, Pa., especially for the production of such very large eye-bars.

There has been considerable doubt in the matter of strength of forged eye-bars of these unprecedented dimensions. To assume boldly that an eye-bar of 30 to 40 sq. ins. cross-section has the same unit strength as a test-piece of ½ to 1 sq. in. section has been questioned as a procedure which needs experimental verification. This mat-

RESULTS OF FULL-SIZED AND SPECIMEN TENSILE TESTS OF LARGE STEEL EYE-BARS; PHOENIX IRON CO., PHOENIXVILLE, PA.

Full-Sized Tests Made on Phoenix 1,200-ton Machine.

Number of Heat.	Test Number.	Kind of Test-piece.	Ultimate Strength, lbs. per sq. in.	Elastic Limit, lbs. per sq. in.	Rupture Elongation, per cent.	Reduction of Area at Fracture, per cent.	
14,067	....	Three specimens.....	63,970	38,770	27 (in 8 ins.)	44.4	
"			65,180	40,550	27.5 "	47	
"			66,810	41,760	30 "	51.8	
		Average.....	65,320	40,360	28.2 "	47.7	
"	646	Two full-sized, 15 × 1¼ in. eye-bars.	60,900	35,250	41 (in 12 ins.) 16.7 (in 10 ft.) 16.9 (in 15 ft.)	40.9	Actual area of cross section, 18.72 sq. ins. Length, 20.54 ft. c. to c. pins. Pin-holes, 12.03 ins. diam. Excess of metal in sections through centers of pin-holes, 43.9 and 44.4%. Fracture occurred 5.2 ft. from ctr. of pin-hole
"	647		61,220	35,580	38 15.8 15.1	32.9	Actual area, 18.72 sq. ins. Length, 20.54 ft. c. to c. Pin-holes, 12.03 ins. Excess in heads, 54 and 43.6%. Fracture occurred 5.1 ft. from center of pin-hole.
		Average.....	61,060	35,415	39.5 (in 12 ins.) 16.2 (in 10 ft.) 16.0 (in 15 ft.)	36.9	
		Full-sized lower than specimen	6.5%	12.3%	.....	22.7%	
15,281	....	Three specimens.....	60,720	39,370	26 (in 8 ins.)	35.5	
"			65,320	38,180	25 "	33.9	
"			64,730	38,970	28 "	43	
		Average.....	63,590	38,840	26.3 "	37.5	
"	648	Four full-sized, 15 × 2-in. eye-bars.	56,200	33,800	48 (in 12 ins.) 19.4 (in 10 ft.) 18.2 (in 15 ft.)	48.2	Actual area, 30.0 sq. ins. Length, 20.48 ft. c. to c. Pin-holes, 12.07 ins. Excess in heads, 48.5 and 57.3%. Fracture occurred 5.1 ft. from ctr. of pinhole.
"	649		57,000	34,000	49 (in 12 ins.) 20.2 (in 10 ft.)	47	Actual area, 30.0 sq. ins. Length, 14.24 ft. c. to c. Pin-holes, 12.06 ins. Excess in heads, 38.7 and 50.3%. Fracture occurred 5.45 ft. from ctr. of pin-hole.
"	695		56,200	30,500	48 (in 12 ins.) 16.6 (in 16 ft.)	54 8	Actual area, 30.0 sq. ins. Length, 21.25 ft. c. to c. Pin-holes, 12.04 ins. Excess in heads, 42.5 and 49.7%. Fracture occurred 12.08 ft. from ctr. of pin-hole.
"	696		55,800	30,700	50 (in 12 ins.) 17.3 (in 17 ft.)	49.3	Actual area, 30.0 sq. ins. Length, 21.43 ft. c. to c. Pin-holes, 12.04 ins. Excess in heads, 43.2 and 38.2%. Fracture occurred 12.54 ft. from ctr. of pin-hole.
		Average.....	56,300	32,250	48.75 (in 12 ins.)	49.8	
		Full-sized lower than specimen	11.5%	17%	.....	—32.8% (greater)	
14,074	....	Three specimens.....	65,440	40,310	25.5 (in 8 ins.)	41.4	
"			67,000	39,550	28.5 "	45.7	
"			61,780	35,230	29 "	39.4	
		Average.....	64.740	38,360	27.7 "	42.2	
"	697	Two full-sized, 15 × 2-in. eye-bars.	54,100	34,420	43 (in 12 ins.) 19.7 (in 16 ft.)	40	Actual area, 30.5 sq. ins. Length, 21.45 ft. c. to c. Pin-holes, 12.04 ins. Excess in heads, 38.5 and 44.0%. Fracture occurred 5.67 ft. from ctr. of pin-hole.
"	698		60,000	34,720	46 (in 12 ins.) 19.7 (in 16 ft.)	45.8	Actual area, 30.5 sq. ins. Length, 21.39 ft. c. to c. Pin-holes, 12.04 ins. Excess in heads, 36.4 and 41.2%. Fracture occurred 7.08 ft. from ctr. of pin-hole.
		Average.....	57,050	34,570	44.5 (12 ins.) 19.7 (16 ft.)	42.9	
		Full sized lower than specimen	11.9%	9.9%	.....	— 1.7% (greater)	
16,672	....	Three specimens.....	60,320	31,550	31 (8 ins.)	52.9	
"			60,310	34,460	32 "	52.2	
"			62,560	34,520	30 "	47.0	
		Average.....	61,060	33,510	31 "	50.7	
"	704	One full-sized, 15 × 1¼-in. eye-bar	57,190	30,740	47 (in 12 ins.) 20.3 (in 16 ft.)	49.3	Actual area, 25.18 sq. ins. Length, 21.38 ft. c. to c. Pin-holes, 12.04 ins. Excess in heads, 52.1 and 45.95%. Fracture occurred 10.64 ft. from ctr. of pin-hole.
		Full-sized lower than specimen	6.3%	8.3%	.....	2.8%	
7,656	....	Three specimens.....	66,890	36,360	23 (8 ins.)	40.8	
"			64,440	35,860	26 "	33.4	
			63,520	34,550	23 "	32.8	
		Average.....	64,950	35,590	24 "	35.7	
	702	Two full-sized, 15 × 2⅛-in. eye-bars.	58,230	30,590	43 (in 12 ins.) 20.7 (in 16 ft.)	44.5	Actual area, 30.4 sq. ins. Length, 21.44 ft. c. to c. Pin-holes, 12.04 ins. Excess in heads, 43.7 and 44.9%. Fracture occurred 3.53 ft. from ctr. of pin-hole.
	703		61,680	31,580	46 (in 12 ins.) 26.5 (in 16 ft.)	41.3	Actual area, 30.4 sq. ins. Length, 21.98 ft. c. to c. Pin-holes, 12.07 ins. Excess in heads, 55.3 and 48.5%. Fracture occurred 3.53 ft. from ctr. of pin-hole.
		Average.....	59,950	31,080	44.5 (12 ins.) 23.6 (16 ft.)	42.9	
		Full-sized lower than specimen	7.7%	12.7%	.....	— 20.2% (greater)	

ter was brought up especially in the discussion on the Manhattan Bridge designs, when the wire-cable and the stiffened eye-bar chain were opposed to each other. It was asserted repeatedly that the actual strength of eye-bars 14 ins. or more in width, with sectional areas of 25 to 40 sq. ins., is a wholly unknown quantity, since there is no warrant for assuming that the unit strength of such bars is as high as that of test specimens having a cross-sectional area less than 2% of the eye-bar.

At the Phoenixville plant, where the Quebec cantilever bridge is being built, full-size rupture tests of the very large eye-bars for this bridge have been going on parallel with the regular specimen tests. A few weeks ago we showed a picture of a 16 × 2 in. bar which had been tested to destruction in the 1,200-ton Phoenix machine, and gave the values for the bar determined from this test. These values, however, were unaccompanied by the values found from the regular specimen tests, so that they threw no light on the relation between the properties as ordinarily determined, in specimen tests and the full-size test results. Through the courtesy of the Phoenix Iron Co. we are now able to present a series of comparison tests in which this relation is well shown.

The tests, all of which were made within the last few months, are in sufficient number, and agree well enough among themselves, to constitute a fairly reliable basis for estimating the strength of large eye-bars from the strength of small-size specimens. The specimen tests here recorded are in groups of three, so that the accidental variations in these tests should counterbalance. The full-size tests of bars made from heats corresponding to the test specimens are in groups of one to four bars, eleven full-size tests being recorded for the five separate blows or heats represented.

We have tabulated the tests in form for convenient comparison, and have computed, for each heat, the percentage difference between the average results of the full-sized tests and the average specimen results. It will be seen that Ultimate Strength and Elastic Limit show a quite constant difference, in all five heats, while Elongation and Reduction of Area show much more discordant figures. Elongation can not fairly be compared for full-size and specimen tests, as will be evident from the table. The difficulties in measuring the standard 8-in. elongation in specimen tests appear more strongly, even for much greater lengths, in full-sized tests, and a fair comparison could only be made on an arbitrarily-selected "standard" basis. The variations of Reduction of Area also seem somewhat erratic, though on the average the figure is about the same for full-sized and specimen tests, as might be expected.

The comparisons for Ultimate Strength and Elastic Limit seem quite satisfactory. It will be noted that the decrease in Elastic Limit is usually more than the decrease in Ultimate Strength. A fair conclusion from the values in the table would be that the full-sized bars there represented have an ultimate strength 8% less, and an elastic limit 12% less, than the corresponding values of ordinary specimen test-bars.

It is much to be desired that the material here presented should be supplemented by further data of the same kind.

SEPTIC TANKS AND INTERMITTENT SAND FILTERS AT SARATOGA SPRINGS, N. Y.

Since July, 1903, the sewage of Saratoga Springs, N. Y., has been screened, lifted by electrically driven centrifugal pumps 15 ft. through a 16-in. cast-iron main 8,835 ft. long, and then passed in succession through covered septic tanks, an aerator, an automatic dosing tank and intermittent sand filters. The volume treated has ranged from 1,250,000 to 2,500,000 U. S. gallons per day. There are four septic tanks of 250,000 gallons capacity each, only three of which have been used, and 18 acres of filter beds.

As is well known, Saratoga Springs is an inland summer resort. Its permanent population was 8,421 in 1870, 11,975 in 1890, and 12,409 in 1900. The summer population increases rapidly to a maximum of 50,000 in August and is assumed, for sewage works purposes, as 40,000.

Mr. F. A. Barbour, M. Am. Soc. C. E., of Snow & Barbour, Boston, Mass., was engineer for the sewage works. The text of this article is based on a paper read by Mr. Barbour before the Sanitary Section of the Boston Society of Civil Engineers on Jan. 4, 1905, and the illustrations were prepared from drawings and photographs supplied to us by Mr. Barbour.*

Table Showing the Hourly Rate of Discharge of Main Sewer at Saratoga Springs, N. Y., on Three Different Days:

Time.	May 1-2. Rate in 1,000 galls. per 24 hours.	May 1-2. Per cent. of daily average.	June 25-26. Rate in 1,000 galls. per 24 hours.	June 25-26. Per cent. of daily average.	Aug. 10-11. Rate in 1,000 galls. per 24 hours.	Aug. 10-11. Per cent. of daily average.
7-8 a. m.	2408.	97.0	2319.	93.2	2606	96.0
8-9 " "	2520.	101.0	2638.	106.0	3037.	112.0
9-10 " "	2740.	110.0	2856.	114.0	3140.	116.0
10-11 " "	2649.	106.0	2928.	118.0	3230.	119.0
11-12 " "	2902.	116.5	2902.	117.0	3265.	120.0
12-1 p. m.	2778.	112.0	2682.	108.0	3252.	120.0
1-2 " "	2708.	108.9	2580.	103.0	3123.	115.0
2-3 " "	2804.	113.0	2591.	104.0	3100.	114.0
3-4 " "	2630.	106.0	2590.	104.0	3043.	112.0
4-5 " "	2610.	105.0	2659.	107.0	2990.	109.0
5-6 " "	2497.	100.0	2734.	110.0	2791.	103.0
6-7 " "	2472.	100.0	2682.	109.0	2932.	108.9
7-8 " "	2487.	100.0	2643.	106.0	3182.	116.0
8-9 " "	2406.	99.2	2640.	104.0	3100.	114.0
9-10 " "	2441.	98.5	2584.	101.0	2931.	107.0
10-11 " "	2340.	94.5	2512.	99.0	2647.	97.5
11-12 " "	2299.	92.5	2454.	95.0	2494.	91.0
12-1 a. m.	2292.	92.4	2364.	90.0	2338.	86.0
1-2 " "	2256.	91.5	2243.	95.0	2517.	87.5
2-3 " "	2233.	90.0	2061.	90.0	2054.	76.5
3-4 " "	2241.	90.0	1983.	83.0	1952.	72.0
4-5 " "	2240.	90.0	1995.	70.0	1912.	70.0
5-6 " "	2236.	90.5	2002.	80.0	1912.	70.0
6-7 " "	2289.	92.0	2137.	80.0	2015.	74.0
Average	2482.	....	2494.	....	2724.	....

FIG. 1. GENERAL VIEW OF SEWAGE FILTER BEDS, SARATOGA SPRINGS, N. Y.

(One of the two sludge beds in foreground; aerator and covered dosing tank at the left; dose of sewage being applied through carrier at the right and rear.)

the Adirondack Mts., but a portion of it is spread over a sandy plain to the southward. The surface drainage of the village flows naturally into Village Brook, thence into Lonely Lake, thence to Saratoga Lake and finally through Fish Creek into the Hudson River.

WHY SEWAGE TREATMENT WORKS WERE ADOPTED.

The original sewerage system was on the combined plan, with a 36-in. single ring brick outlet

*The paper will be published in a future number of the Journal of the Association of Engineering Societies.

sewer which discharged into Village Brook about 5,000 ft. south of the thickly settled portion of the village. As early as 1882 complaints of nuisance below the outlet led to the appointment of a commission, and subsequently the outlet was extended about five miles to Kayaderosseros Creek, a tributary of Saratoga Lake. Although the original outlet was 36 ins. in diameter and had a carrying capacity of 35 cu. ft. per sec., the extension was 24 ins. in diameter and carried only 7 cu. ft. per sec. Thus only the dry weather flow was to be conveyed further away from the village. Between the old outlet sewer and the extension a small settling tank was built.

Subsequently 23 damage suits were filed against the village: 19 based on the discharge of storm water into Village Brook, and four on the dry weather flow into the creek at the lower end of the outlet extension. Four cases were carried to the Court of Appeals and lost by the village. Altogether, the village paid more than $20,000 damages. The complainants urged that the sewage caused offensive odors, fouled the water so cattle would not drink it, and also fouled meadow land. It may be noted that the overflow into the brook could take place only when the total flow through the original sewer was 5,000,000 gallons a day, and when the stream was so swelled as to afford a dilution "within the limits of the standard usually set for the prevention of a nuisance."

As a result of an investigation made by the State Department of Health in 1899, and on its recommendation, Governor Roosevelt, acting under Chapter 661 of the New York Laws of 1893, ordered the village to put in sewage disposal works by April 1, 1900. A similar order, on like grounds, was issued against the village of Ballston Spa, which has not yet built works, but is preparing to do so. Snow & Barbour were employed in 1899 to make plans for intermittent sand filters, but pending investigations and measures for curtailing water waste and construction of drains to separate the storm water and sewage, an extension of the time set for completing the sewers was obtained. Meanwhile a change was made in the sewage disposal scheme.

REDUCING WATER WASTE, EXCLUDING STORM WATER AND ESTIMATING THE VOLUME OF SEWAGE TO BE TREATED.

The water supply of Saratoga Springs is pumped directly to the consumers. In 1899 to 1901 3,000 meters were installed at a cost of about $25,000, and the consumption reduced from a range of about 225 to 400 gallons to 110 to 130 gallons per capita, the high figures being in the winter months. During the same period surface water sewers were built at a cost of about $40,000, the old sewers in the same streets being retained for house sewage only.

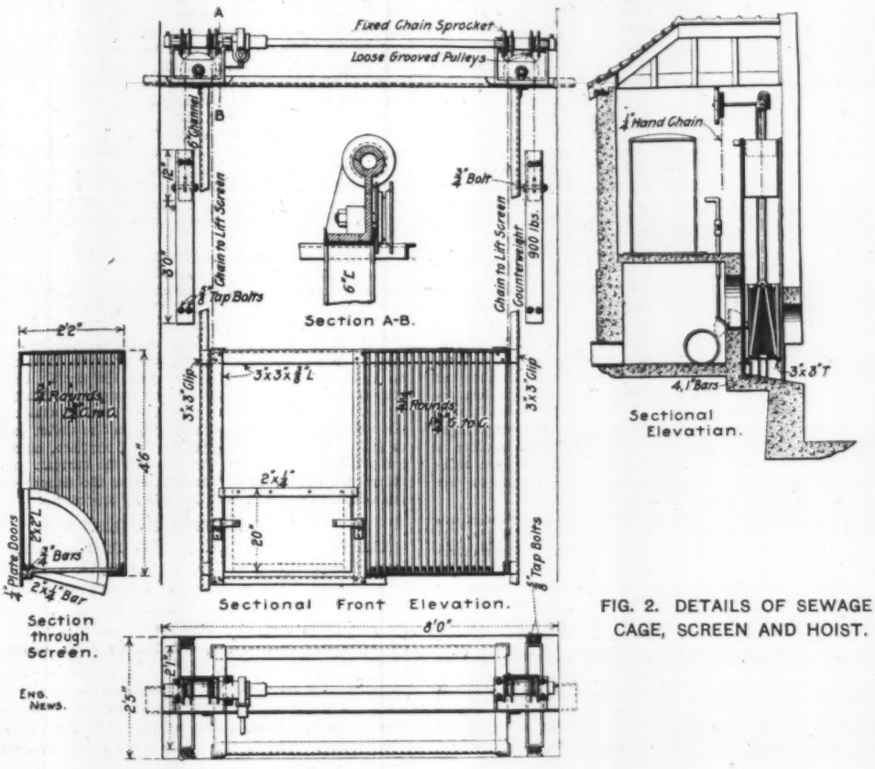


FIG. 2. DETAILS OF SEWAGE CAGE, SCREEN AND HOIST.

Before proceeding with the design of the sewage works, a weir was built in the settling tank at the end of the old 36-in. sewer and on several dates hook gage readings were taken at intervals of 15 minutes throughout a period of 24 hours. The results of these measurements are shown in the table on the preceding page.

The discharges shown in the table included the flow from a number of springs, which would be cut out in case a proposed new sewer were built. To estimate the volume of sewage if this water were diverted a specially devised Pitot tube was used at frequent intervals in the main sewer and also in the laterals. This tube, which was considered accurate enough for the work in hand, is described by Mr. Barbour as follows:

> It consisted merely of two brass tubes with elbows at the bottom, one pointing up-stream and one at right angles, and glass gages in their length, both tubes firmly attached to a collar which could be moved up and down on a vertical standard and fastened at any elevation by a set screw. Each brass tube had a stop cock just above the elbow, these stop cocks being opened or closed by geared pinions through the movement of a double-faced rack. By placing the standard on the invert of the sewer and lowering the collar until the mouth of the tube was at the proper level, then opening the stop cocks and, after an interval, closing, the liquid would be caught in the two tubes. The apparatus could then be lifted up to read the difference of level in the two gages, and the velocity of flow so ascertained. Where the depth of flow was very small, a partial vacuum could be created in the tubes by a rubber bulb, and the liquid made to rise so as to be readable in the glass gages. The instrument was calibrated, by comparing the discharge as measured by it with that given by the weir. It was found that the velocity as shown by tube had to be multiplied by a coefficient of 0.67 in order to give correct results. It may be interesting to note that the velocity as given by floats in a 36-in. sewer flowing one-third full, had also to be corrected by a coefficient of 0.75 in order to agree with the weir measurements.

It was concluded that if a new main sewer was built the ordinary volume of sewage to be treated would range from 1,500,000 to 1,700,000 gallons a day, with a summer maximum of 2,500,000 gallons. The design of the works was based on these figures, and it was recommended that a 15 to 24-in. sewer be built through the valley to the outskirts of the village.

CHOICE OF METHOD OF TREATMENT.

The choice of a method of treatment "lay between some form of high rate plant, reached by gravity," and a low lift pumping plant discharging onto "very desirable sands." In the opinion of Mr. Barbour

> contact beds or streaming filters demand more constant and expert attention than slow sand filtration, and, it was believed, would be less capable of meeting the abnormal variation in the quantity and quality of the sewage to be met with in Saratoga.

The location of the sandy area was almost ideal, "from the standpoint of seclusion and topography," so it was concluded to utilize it.

In the opinion of Mr. Barbour high rate methods of treatment are not justifiable in the present state of the art, where good sand is available, even though pumping to a moderate height is necessitated to reach the sand. With slow intermittent sand filtration, if good sand of sufficient depth can be found, the chief problem is the maintenance of the surface of the beds, which in turn depends on getting rid of the solid matters suspended in the sewage. Although the septic tank is not, as originally claimed, "the final solution of the sludge problem," yet

> if by its use the surface of the filter during periods of low temperature can be kept clean, and if such a portion of the solids can be dissolved as to effectively reduce the cost of maintaining the plant, then in many cases the septic process is justified.
>
> It is not necessary to create a nuisance and if the effluent is properly treated there will be no difficulty in effecting purification. It has been a pronounced success in the personal experience of the writer, but just why as compared with other places where a partial failure has resulted, is a difficult question to answer. The factors essential to success have not yet been determined and will probably only be evolved by a long process of elimination in experience.
>
> In the belief that by its use the abnormal variation in the amount of sewage would be somewhat equalized, that the solids could be withheld from the filters in the summer when the surface appearance is particularly important, and in winter during the period of low temperature, that a large portion of the suspended matter would be liquefied and the cost of maintenance thus reduced, the septic process was adopted at Saratoga.

SEWAGE SCREEN AND PUMPING STATION.

A variety of factors entered into the selection of the pumping plant, which consists of three 6-in. centrifugal pumps, direct-connected on a vertical shaft to electric motors, and provided with automatic starting and stopping apparatus: It was desirable to place the septic tanks at the filter beds and to avoid any considerable amount of storage at the pumps, thus making continuous pumping necessary. To obviate night attendance, several pump units, coming into or going out of action automatically, were required. Two of the three pumps are designed to take care of the maximum flow, leaving the third in reserve.

Fig. 3. View of Sewage Pumping Station.
(A small, strictly utilitarian building may be made dignified and attractive. The walls are of Scotch fire brick and the roof is covered with red Ludowici tile.)

The pumping station is 20 × 25 ft., inside, with an 8 × 10-ft. projection at the rear to house the screen hoist. Fig. 2 shows the location and details of the screen hoist; Fig. 3 is a view and Fig. 4 is a section of the pumping station.

The cage screen is described by Mr. Barbour as follows:

> The screen is a counterbalanced cage which is raised and lowered by a chain and sprocket wheel actuating a worm gear. The cage when full is lifted several feet above the ground floor and the front drops back so as to

permit the raking of the screenings directly into a wheelbarrow. A toothed comb lifts as the screen is raised and serves to temporarily prevent large solids reaching the pump. The screen bars are circular, ¾-in. in diameter and spaced 1¾-in. on centers. This was found to be not close enough for the operation of 6-in. centrifugal pumps of the usual type and a screen of closer mesh was subsequently placed inside the cage. Pumps with larger clearance between the impeller casing and volute will take larger solid but the efficiency is lower than that of the usual type. From more recent work it has been found that square are better than round bars for fine screens and a cage of ⅝-in. bars, spaced 1¼-in. on centers, is about right for small pumps. Experience has also proved that spur gearing, with a rachet to hold the cage at any desired level, is better than worm gearing for the hoist.

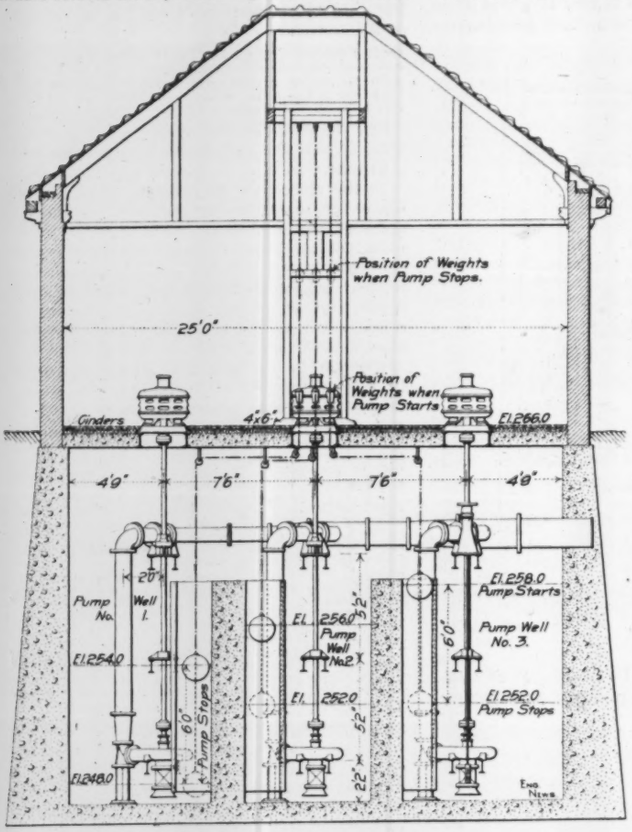


FIG. 4. SECTION THROUGH SEWAGE PUMPING STATION, SHOWING ELECTRICALLY-DRIVEN CENTRIFUGAL PUMPS.

The pump well is 24½ × 12 ft. in plan and its bottom is 10 ft. below the invert of the main sewer. It has a capacity of 16,000 gallons. The sewage passes through the screen into a narrow chamber and thence into one or more of the three pump pits. There is no connection between the pump well and the pump rooms, access being had through the screen room only.

The three 6-in. centrifugal pumps are submerged in the sewage. Each pump has a capacity of 1,000 gallons a minute when working against the head developed with all three in operation. Tests showed that one pump working alone delivered 1,575 gallons per minute against a total head of 27.75 ft. with 775 revs. per min., and two pumps working together delivered 1,180 gallons per minute each, against 37.75 ft. head and with 784 revs. per min. The pumps and motors have an average combined efficiency of 35%, and were installed by R. D. Wood & Co. at a total cost of $5,400. In addition, the pump well cost $2,000, and the building $2,000. Other items (not stated —Ed.) brought the total cost of the pumping plant up to $11,000.

The general method of supporting the pumps in the pump pits and of connecting them with the motors is shown by Fig. 4. The arrangement and character of the pumps and motors and the devices for automatically starting and stopping them are described by Mr. Barbour as follows:

> Each pump is directly connected by vertical shafting, which is guided by two sets of I-beams, with the motor in the room alone. A slip coupling is placed in each shaft just below the floor—the weight of the motor and its shaft being carried by the motor bearing and that of the pump shaft and the thrust of impeller by a thrust bearing set on the higher pair of I-beams. The use of the slip coupling is apparently essential as it is difficult to so otherwise adjust the motor and thrust bearing that each will do its share of the work. It also permits the close adjustment of the impeller to bottom of pump casing, necessary to prevent clogging of the pump by small rags winding around the shaft. The thrust bearing is important in the design of vertical pumping connections, and one of the best types is that used in vertical motors in which the oil is continuously and automatically circulated by centrifugal force.
>
> With an alternating current of a given frequency the speed of the motor can be regulated only within the choice of the number of poles. For close adaptation of the discharge of the pumps it is, therefore, necessary to vary the diameter of impeller and the resulting circumferential velocity. The slip of the motor must be taken into account and allowance made for the fact that in many cases generators are not run up to speed. The obtaining of the desired number of revolutions is important because a small reduction in the speed of centrifugal pumps, operating against a certain head, makes a relatively large reduction in the discharge.
>
> The motors at Saratoga are vertical six pole 20-HP. induction motors using a three-phase current of 40 cycles frequency. The power is obtained from the Hudson River Power Co., at Spier's Falls. The current is delivered at a primary pressure of 2,300 volts and stepped down by transformers to 220 volts.
>
> The nominal speed is 800 revs. per min., but the actual speed averages from 765 to 785 revolutions. Each pump has an 8-in. suction and 8-in. discharge pipe, a check and straightway valve being placed in each branch discharge. A valve was also placed in the short length of suction pipe below each pump with the idea that when the inflow of sewage was less than the capacity of one pump the suction might be throttled. It is claimed that a centrifugal pump so throttled, in view of decreased forc[e] main friction, will operate with greater efficiency tha[n] when running with full capacity. This has, however, n[ot] yet been tried at Saratoga.
>
> In the corner of each pump pit a 15-in. copper ball [is] floated in a galvanized sheet iron pipe. From the float[s] chains guided by pulleys lead to automatic switches [in] the motor room above. The floats are counter-weighte[d] and as they rise the counter-weights pull down a lever [to] a horizontal position from which a spring quickly com[-] pletes the movement of the switch and starts the motor. As the sewage is lowered, a reverse action of the flo[ats] and switch takes place and at a certain level of the sew[-] age in the well, the motor is stopped. The floats are s[o] arranged that No. 1 motor starts when the sewage reaches Elev. 254, No. 2 at Elev. 256 and No. 3, which is intended to be in reserve, at Elev. 258. In shutting down, the motor which starts last stops first. In this way the pumping capacity, at any time in use, is as nearly adapted to the inflow as is practically possible with this type of plant. The units are interchangeable in their operation and the scheme is—in the opinion of the writer—better than the adoption of pumping units of different capacities.
>
> The automatic starting and stopping apparatus is entirely satisfactory in its operation—although the same danger exists in this as in all automatic apparatus—that it will be altogether neglected. There are certain parts of the plant which require more or less attention at times among these being the switches which although submerged in oil sometimes spark and burn so as to make an imperfect contact. In this way the circuit in two phases and not in the third may be completed, thus burning out the motors. This possibility can be avoided by the use of time-limit relays which, on the motor failing to start or becoming plugged by solid matters, automatically throw out a switch and shut off the current. These relays were installed at Saratoga after the danger existing without them had been learned by experience.

THE SEPTIC TANKS.

The 16-in. force main, 8,835 ft. long, extends from the pumping station to the septic tanks, and is provided with a blow-off located at a brook. The septic tanks adjoin the filter beds, as shown by the plan, Fig. 8. They have a total capacity of 1,000,000 gallons, divided into four units of equal size, 51½ × 91½ ft. in plan, with a sewage depth of 7¾ ft. at the inlet and 8¼ ft. at the outlet end. The tanks were built of concrete. All the walls are 2 ft. thick at the springing line of the arches. The outer walls have a batter on the outside of about 1⅓ ins. per ft., and the division walls increase on both sides to a thickness of 3 ft. at the underside of the floor. The piers are 18 ins. square, with tops enlarged to 22 ins. and bases to 30 ins. square (see interior view, Fig. 5). The elliptical groined roof arches have spans of 11½ ft., rises of 2½ ft., crown thicknesses of 6 ins.

FIG. 5. INTERIOR VIEW OF COVERED SEPTIC TANK, SARATOGA SPRINGS, N. Y., LOOKING TOWARDS OUTLET END.

FIG. 6. VIEW OF AERATOR AND COVERED DOSING TANK, SARATOGA SPRINGS, N. Y.

and depression of 9 ins. over the piers, drained by 2-in. pipes leading into the tank. The floor is composed of inverted spherical groined arches, from 6 to 12 ins. thick.

Sewage is admitted to the tanks at a level 3½ ft. below the water line through four openings in a pipe supported on a concrete bracket. The sewage may be turned into one or more tanks at will or by-passed to the filter beds. The effluent passes from the tanks through two horizontal rows of 2-in. pipe (see Fig. 5) placed about 3½ ft. below the high sewage line. These pipes discharge into a narrow chamber, extending the length of each tank and provided with a weir over which the effluent passes to the respective outlet chambers. These weirs serve the double purpose of affording an opportunity to measure the sewage passing through each tank and to regulate the flow thereto through the inlet gate. Other weirs make it possible to turn the effluent from one tank into another for storage.

Sludge may be drawn off to the sludge beds through a 24-in. gate in the outlet end of each tank (see Fig. 5) and a 12-in. gate, at a higher elevation, is provided for use in drawing down the septic sewage. There are six 3-ft. openings in the roof of each tank.

The total cost of the concrete for the tank averaged about $7 per cu. yd. Portland cement was used and the mixture was 1:2½:3:5, the variation in the sand depending on the percentage of voids in the sand and stone.

THE AERATOR AND AUTOMATIC DOSING TANK.

From the septic tank outlet chambers a 16-in. pipe extends to the bottom of the aerator, shown in Figs. 6 and 7; or the septic effluent may be sent directly to the adjacent dosing chamber.

The dissolved oxygen test of the sewage at various stages has shown the following percentages of saturation: Sewage entering septic tanks, 4.3%; effluent before aeration, 0.0; immediately after aeration, 70.4; effluent applied to filters, 40.4%. By way of comment Mr. Barbour says:

> These figures indicate the avidity of the liquid for oxygen, and while it may be difficult to demonstrate the actual value of this special aeration, it is reasonable to believe that otherwise the available oxygen in the beds would be used up preliminary to the commencement of nitrification. At all events, there has been no difficulty at Saratoga in effecting nitrification of the septic effluent.

The relation of the aerator and dosing tank and the details of the latter are shown by Fig. 7. The combined capacity of the aerating chamber and dosing tank is 26,000 gallons, which, combined with the average rate of inflow during discharge, gives a dose of about 35,000 gallons.

The lower leg of the 18-in. Miller siphon shown in Fig. 7 ends in a 24-in. cylinder, provided with four equidistant 12-in. circular openings, which connect with pipes enlarging to 24 ins. in diameter and extending to serve as many groups of filter beds. Continuing Mr. Barbour says:

> Inside the four-way cylinder another cylinder with one opening is made to revolve by the rise of a float. This float carries a rack which through gearing transmits the motion to the vertical shaft of the inside cylinder or revolving gate in such a way that for each rise of the float the cylinder turns one-quarter of a revolution, registering in turn with each of the four openings of the outer cylinder.
>
> The siphon, although designed to discharge at a certain depth of water, is operated mechanically by the action of a small float which opens a valve and permits the air under compression to escape. This float can be set at any height and the size of dose thus changed as may be desired.
>
> The connection of float with cylinder is made through a four-pawl rachet, which while serving to turn the cylinder on the upward motion of the float permits the float to descend without causing a reverse movement of the cylinder. The apparatus is simple and positive in its operation and makes possible the application of the sewage regularly during the day and night in doses of the desired amount with no attendance other than occasional oiling.
>
> The siphon discharges at a rate varying from 10 cu. ft. per sec. at the beginning of its operation to 7.5 cu. ft. at the end. The actual velocity in this siphon is equal to the theoretical velocity for the head between the inner and outer surfaces of water multiplied by a coefficient of 0.95.
>
> The revolving cylinder can be turned by hand and the sewage can be flowed directly into this cylinder without passing through the siphon, in this way cutting out the dosing tank and making the discharge continuous.
>
> The dose of 35,000 gallons applied at a rate of 8 cu. ft. per sec. is well distributed over the beds one acre in area with a sand .20 mm. "effective size." It is large enough in all but extreme conditions of temperature, when a greater dose is desirable in order to keep the beds open.

THE INTERMITTENT SAND FILTER BEDS.

There are 20 filter beds, 18 of about one acre in area each and two somewhat smaller. Borings with a sand augur showed that the material at the site of the beds was first 8 ins. of loam, then 2 ft. of subsoil and then a layer of sand of unknown depth, with the ground water level at about 16 ft. below the surface. The sand was found to have an effective size of about 0.20 mm. and a uniformity coefficient of about 2.0.

The embankments were built of yellow subsoil and finished with 9 ins. of the loamy top soil. In bringing the beds to grade the sand for filling was selected so as to avoid abrupt changes in the size of the grains. In grading use was made of wheel scrapers, wheelbarrows and two-horse wagons with slatted bottoms. The grading cost the contractor about 17 cts. per cu. yd., of which 5 cts. was for "trimming up and sand papering of surfaces."

The means employed to distribute the sewage, including the surface carriers, are thus described in Mr. Barbour's paper:

> The rate of discharge is an important factor in successful distribution. At Saratoga the main pipes, outlets and carriers are all designed to carry 8 cu. ft. per sec. The distribution pipes are generally 24 ins. in diameter, laid in trenches excavated after the embankments had been raised to an elevation of 2½ ft. above the grade of the pipe. Gate chambers of 8-in. brickwork and 4-in. concrete slab covers are placed opposite the center of the beds and contain the gates necessary to deflect the sewage to any bed desired.
>
> The outlet pipes are 15 ins. in diameter and protected at the outer ends by concrete abutments. From these abutments a carrier (see Figs. 8 and 9.—Bl.) extends 180 ft. across the bed. Its width is decreased from 5 ft. at the embankment to 1 ft. at the far end by abrupt reductions of 6 ins. on each side at four points—in this way slicing off the sewage into ten parts of practically equal amount. By reducing the width a uniform depth of flow is maintained and a self-cleansing velocity made possible. Adjustable wooden gates at the outlets serve to regulate the discharge if it is desired to throw unequal quantities on different parts of the beds. The bottom of the carriers is of Portland cement concrete, mixed 1:3:5, 6 ins. thick, laid in sections of about 8 ft. in length, with tarred paper between each section to prevent temperature cracking at random points. Iron bars were set in the concrete, extending across the entire width of the carrier and turned up at the ends to serve as supports for the 2-in. plank sides. These carriers, which are the same as have been used at a number of other places, are an entire success

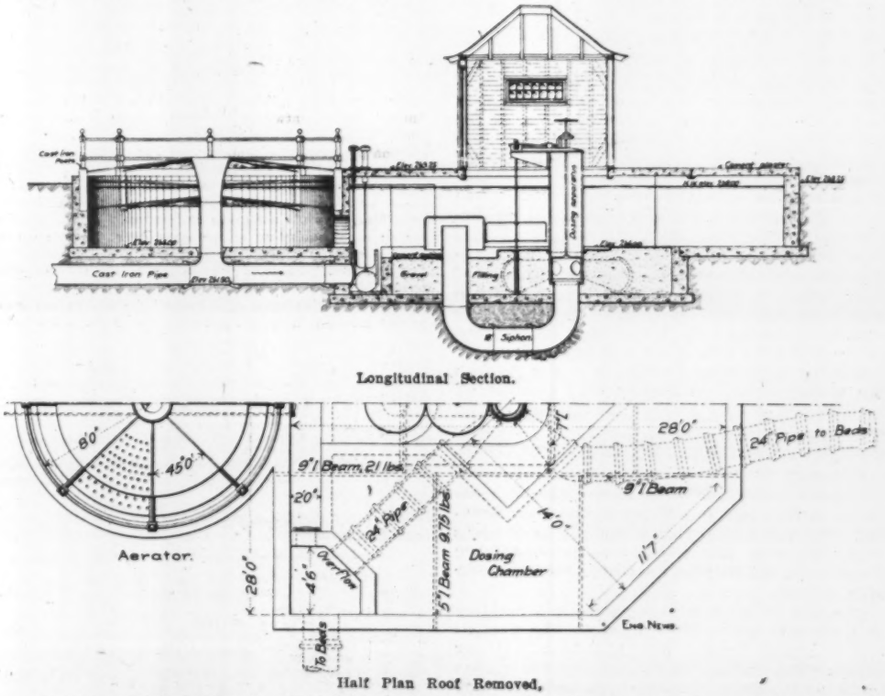


FIG. 7. HALF-PLAN AND LONGITUDINAL SECTION OF SEWAGE AERATOR AND DOSING TANK, SARATOGA SPRINGS, N. Y.

in effecting the uniform distribution of the sewage over the beds. In the opinion of the writer there is no other feature in sewage filtration work as important as the dosing of the filters at such a rate, in such quantities and in such a way as to quickly and evenly spread the sewage over the entire bed.

Owing to the depth of the sand and of the water table at the site of the filtration area, only one line of underdrains was placed in each bed. This was put at a depth of about 6½ ft., and each

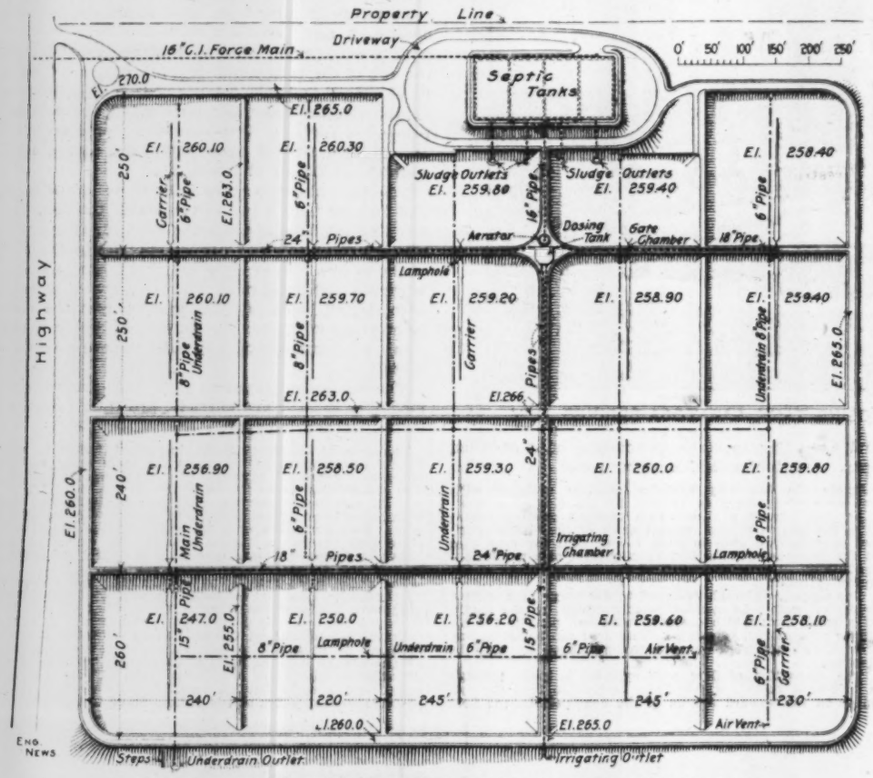


FIG. 8. PLAN OF SEWAGE FILTER BEDS, SARATOGA SPRINGS, N. Y.

line was connected with a line of 10 to 15-in. main drain, 11 ft. in depth. At the junction of the lateral drains and the main drain manholes were built and at its outer end each lateral underdrain was extended vertically to and above the surface of the filter beds, thus forming air vents. These vents are finished with cast-iron pipe, having perforated hemispherical ends. It is believed that the vents will be beneficial through reducing the "accumulation of carbonic acid gas in the body of the filters." At Brockton, Mass., where no vents were provided, "the collection of this gas is so pronounced that a lighted lantern is extinguished in the manholes 2 ft. below the surface."

Not one quarter of the filtrate passes through the underdrains, "the greater part running off through the ground without appreciably raising the water table."

COST OF CONSTRUCTION AND OPERATION.

Including $40,000 for the new storm water sewer and $25,000 for water meters, the improvements at Saratoga Springs have cost about $200,000. The approximate cost of some of its divisions was: Pumping plant and accessories, $11,000; force main, $25,000; septic tanks, $15,000; filter beds, $48,000.

The cost of operating the pumps and purification works is about $3,000 a year. The average cost of power for pumping has been $60 per month. The engineer of the water-works station visits the sewage pumps once or twice a day, and the screenings from the sewage, which amount of 250 lbs. a day in August and 170 lbs. the remainder of the year, have to be removed several times a week. About $50 a month may be allowed for all services at the screen and pumps. At the filter beds an average of about $140 per month is expended, of which two-thirds is for trimming embankments, weeding drives and other work not related to the maintenance of the surface of the filter beds.

METHODS AND RESULTS OF OPERATION.

On these subjects Mr. Barbour will be quoted in full, as follows:

The plant was placed in commission in July, 1903—the writer having charge of its operation until September, 1904. Systematic analyses of the sewage, septic effluent and filtrate were made during this time and gagings of the scum and deposit in the tanks taken with the Fowler sludge gage once each week.

The quantity of sewage varies with the season and the rainfall and ranges from 1,250,000 gallons to double this amount. It is relatively weak except in the months of July and August—the average free ammonias equaling 2.0 parts, the total albuminoid ammonias, 0.40 parts, the oxygen consumed 5.0 parts, and the suspended solids 20.0 parts per 100,000. The samples from which these figures were derived, while not taken as frequently as is desirable for an exact statement of the work done, were in every case collected in small portions at intervals throughout the day and well express the conditions at the time of collection.

Since the beginning of operation all the sewage has been passed through three of the tanks—the fourth never having been filled. The time of retention in the tanks has varied from 10 to 15 hours, the shorter period being in the month of August when the sewage is strongest, but also when the temperature is highest and the bacterial activity greatest. About 65% of the suspended solids have been removed by the septic treatment and the remainder so finely comminuted and decomposed as to nullify its capacity for forming deposits on the filters. The tanks have never been emptied and no solid matter has been taken from them. Not more than five tons of scrapings have been removed from the surface of the filters and this only because of an excessive zeal for cleanliness.

At the present time there is 10% less solid matter in the tanks than there was one year ago, and it would seem as if the operation might extend indefinitely without drawing off any sludge. Septic treatment was begun at the time of maximum population, the result being a rapid accumulation of solids during the first two months. The action was hardly established before cold weather set in and the most severe winter in the memory of Saratoga encountered. The average of the lowest daily temperatures for the three months of December, January and February was + 9.3° F.; in February it was + 4.8°. There were 28 days of zero weather and a minimum of — 32° was recorded. These figures are interesting as an indication of the temperatures at which sand filters can be successfully operated.

The scum in the tanks became frozen to a depth of several inches under the masonry roof and 18 ins. of earth covering. It would seem as though open tanks in such conditions would hardly be feasible. Judging from the results at Saratoga the process of anaerobic liquefaction is perhaps more intimately dependent on temperature than is the process of nitrification. The depth of scum and deposit continuously increased up to April when about 44% of the entire volume of the tank was occupied by these accumulations as measured by the Fowler gage. At this date the temperature of the liquid in the tanks had fallen to 41° F.

The following figures show the character of the scum and deposit as measured by the gage:

	Scum, per cent.	Deposit, per cent.
Moisture	86.5	94.0
Volatile matter	10.0	4.5
Mineral residue	3.5	1.5

In May the temperature of the liquid in the tanks had increased to 50° F. and the scum and deposit had reduced to 35.7% of the volume of the tank. In June the corresponding figures were 59° and 24.5%, in July 63° and 23.4%. In August, when the sewage reached its maximum temperature of 70°, the volume occupied by the scum and deposit had fallen to 21.4%. Since then the temperature has lowered and the accumulated solids on Jan. 1, 1905, occupied about 25% of the tank volume.

About 1,000,000 lbs. of dry solid matter have entered the tanks since the beginning of operation and 350,000 lbs. of these solids have passed out in the effluent. This latter portion has been so decomposed that no visible deposit in amount large enough to attempt its removal has appeared on the beds.

The specific gravity of the scum averages about 0.975 and of the deposit 1.025. On Jan. 1, 1905, about 200,000 lbs. of dry solid matter remained in the tanks, of which 25,000 lbs. was in the form of deposit and the balance in the floating scum. It therefore appears that 450,000 lbs. of solid matters which have entered the tanks have altogether disappeared by liquefaction. The sewage is strictly domestic and probably the most favorable for successful treatment by this method.

The purification of the septic effluent has varied from 90.3% in December, 1903, to 79% in March, 1904, on the basis of the free ammonias in the raw sewage and the filtrate. The nitrates have ranged from 0.5 to 2.5 parts per 100,000.

In midsummer twelve beds are used daily, the gates being changed twice; during the remainder of the year eight beds are used daily, one shift of the gates being necessary. The average daily amount of sewage per bed

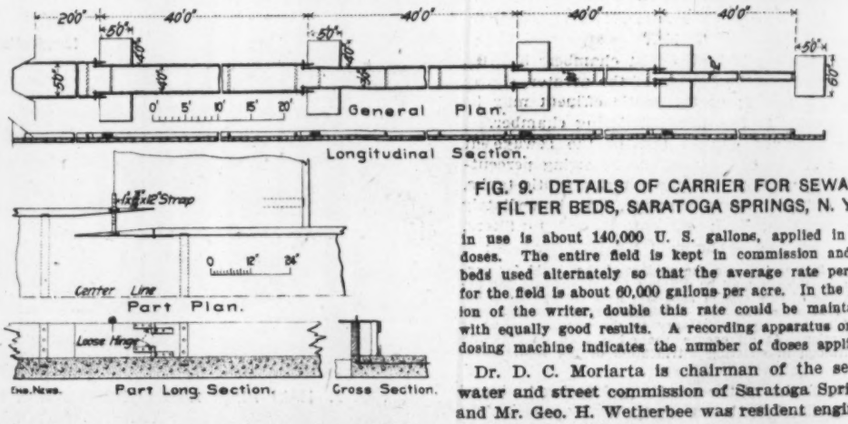


FIG. 9. DETAILS OF CARRIER FOR SEWAGE FILTER BEDS, SARATOGA SPRINGS, N. Y.

in use is about 140,000 U. S. gallons, applied in four doses. The entire field is kept in commission and the beds used alternately so that the average rate per day for the field is about 60,000 gallons per acre. In the opinion of the writer, double this rate could be maintained with equally good results. A recording apparatus on the dosing machine indicates the number of doses applied.

Dr. D. C. Moriarta is chairman of the sewer, water and street commission of Saratoga Springs, and Mr. Geo. H. Wetherbee was resident engineer in charge of construction.

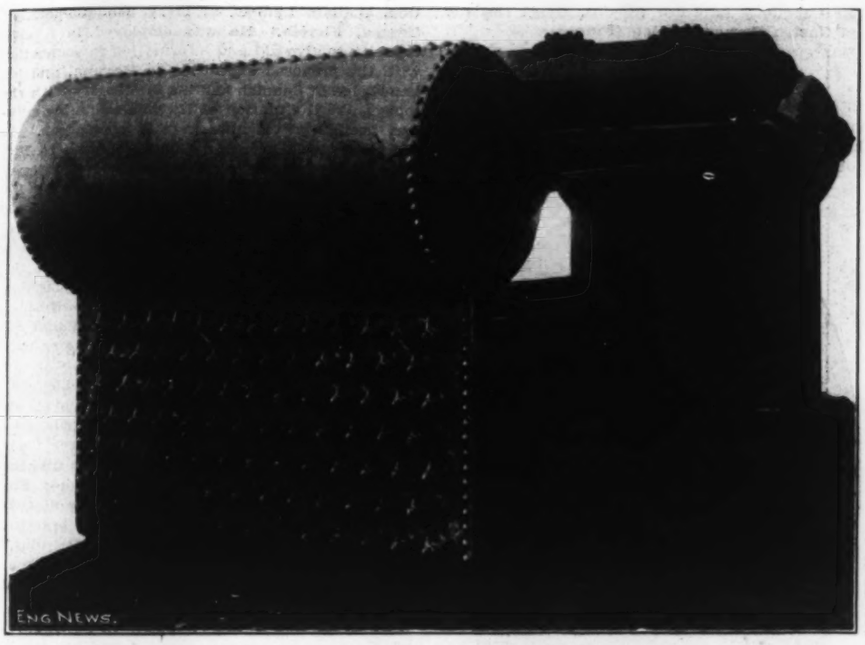
A BANANA ELEVATOR AND CONVEYOR for unloading cargoes of bananas is illustrated in "The American Syren and Shipping," Jan. 14, 1905. The elevator was installed 18 months ago on the wharf of the Illinois Central R. R., at New Orleans. The capacity of the machine is 2,500 bunches of bananas per hour, and in 12 hours work not more than about 10 bunches are damaged.

A NEW WATER-TUBE BOILER.

We illustrate herewith a water-tube boiler which is being manufactured by the Atlas Engine Works of Indianapolis, and which involves some novel features of construction.

As all engineers familiar with water-tube boiler design are aware, the feature of the boiler involving greatest difficulty is the design of the headers and their connection to the collecting drums overhead. In the boiler here shown, each header is made up of two flat, parallel steel plates, which are actually one piece with the drum over them. Thus the boiler consists, practically, of the front and rear drums with a staybolted water leg connected to each and with tubes connecting the water legs and the drums. To withstand the internal pressure at the junction of the water leg and the drums, a patent twisted brace is used which leaves over 80% of the cross-section open for the passage of water. The circulation in the boiler should, therefore, be excellent.

By this method of construction also, no seams are exposed to the fire. The only seam in the water legs is at the bottom, where it is protected by the masonry, while the seams of the drums are located on the top, away from the fire.



A NEW WATER-TUBE BOILER.
The Atlas Engine Works, Indianapolis, Builders.

The rear drum contains a mud pan through which the feed water flows and where the impurities of the water are precipitated, from which a connection through the drum head admits of its being blown out. This mud pan is built in sections and can be removed through the manhole of the drum and renewed at small expense when it becomes pitted.

Each of the larger drums is connected with a middle drum by tubes and the steam as it is released goes to the middle drum, from which it is taken for use. Experience has shown that by thus carrying the steam to a third drum through tubes exposed to the furnace gases not only is perfectly dry steam obtained, but this steam is given 10° to 20° of superheat.

A considerable number of these boilers have been placed in service and the manufacturers have recently booked a large order from Japan.

ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ARCHITECTS.

The regular annual convention of the American Institute of Architects was held at Washington, D. C., on Jan. 11 to 13, 1905. The convention heard and discussed several professional papers, elected officers for the coming year, and transacted a great amount of routine business. A banquet at which many notable men in private and public life, including President Roosevelt, were present, formed the central feature of the convention.

The American Institute of Architects differs from our national engineering societies in character in making an examination of candidates for membership a necessary condition of election, in establishing a standard of fees for architectural service, and, in general, in aiming to create a fixed professional standard. It is divided into local "chapters," 27 in number at present, which carry on most of its work. The national conventions, for these reasons, are devoted more to general business than to technical discussion and interchange of ideas. The following report is therefore restricted to a summary of the more interesting portions of the proceedings.

One of the features of the business of the convention was the adoption of an amendment to the by-laws, raising the annual dues of members by 50 per cent. The dues as revised are $7.50 for Associates and $15 for Fellows. The increase was made for the purpose of enabling the society "to conduct the business of the American Institute of Architects in promoting and forwarding laws," in "emergencies that come up every day in Congress and elsewhere." The legislative work in question includes promotion or opposition of laws affecting civic beauty or otherwise important to the architectural profession. During the past year the Institute has succeeded in preventing the adoption of a law which would have permanently killed the proposed 500-ft. Mall in Washington extending from the Capitol to the Washington Monument. It has also succeeded in defeating a clause in a public building act which specified that the architects' commission was to be 2½ per cent.

The election of officers for the coming year resulted in the choice of the following. President, Mr. W. S. Eames; Vice-Presidents, Messrs. A. Stone and Cass Gilbert; Secretary and Treasurer, Mr. G. Brown of Washington, D. C.

The technical papers and discussions at the convention included the following:

ARCHITECTS AND MUNICIPAL SCHOOL WORK.

Mr. R. Clipston Sturgis, in a paper on this subject, described the system by which municipal school construction is handled in the City of Boston, Mass. The system is new, too new to have yet proved its value, the author says. The more recent steps leading up to the present system were:

(1) A city architect, on salary, with office expenses paid. This official handled all city work, of which the schools formed the larger part. The political nature of the office, and, more important, the excessive amount and range of the work required of its incumbent, made it impossible to secure more than a small proportion of good results.

(2) The architectural work of each department handled by that department. Under this plan the School Committee had charge of planning and constructing new schools, which work is by far the largest part of municipal building work. This body was unpaid, cumbersome, and, as its members were elected by the public, not ideally constituted. The method followed by the committee, usually engaging a new architect for each new building, made the results varied and inconsistent, and did not assure the accumulation of experience such as is necessary to secure the best results in quality and cost. On the face of the question, a body constituted as the School Committee could not be efficient.

In 1900 the State Legislature authorized the appointment of a Board of School-house Commissioners to handle the construction of school buildings in Boston. At present this Board, of three members, comprises a lawyer, a builder and an architect. This Board engages an architect, subject to the Mayor's approval, when a new building is to be designed or important changes made in an existing one. According to the policy of the board, architects are engaged on the basis of their past experience and reputation. The architect is paid 2½ per cent. on the heating and electric work, and 5 per cent. on the rest of the work. He must furnish three sets of mounted blue-prints and one set of tracings corrected after completion of the work. The drawings must be complete in all details, except for full-size drawings. A complete specification must be furnished, which the Board prints. Drawings and specifications of previous schools are open to the architect's inspection. The city provides surveys, borings, location of sewers and mains, and full information as to requirements and cost; it also furnishes the architect experts in heating and electric work. On large buildings, the city employs a superintendent. The architect is required to make a weekly report on a regular form.

The Board maintains a large force of inspectors, including experts on plumbing, roofing, heating, etc., and also a large drafting force capable of handling engineering and architectural work. Repair and maintenance is taken care of by this force.

During the few years that it has been established, this Building Board system has given good results, though full judgment can be rendered only after a longer experience. It is suggested that a similar Board could be instituted to handle all other municipal building work collectively; there would not be enough work in the several departments, outside of the school department, to warrant such a system for each separately.

The system used for handling school construction in Chicago was described in a paper by Mr. W. B. Mundie. In that city the Board of Education, of 21 appointive members, has in charge all school building work, acting through its Committee on Buildings and Grounds. The Board employs an architect on salary, and this official has a large force of assistants, draftsmen, etc. This force is now under Civil Service rules, as is also the department of repairs, both departments being under the direction of the architect.

While the architect's force, under the Civil Service, is approaching a very efficient condition, there is some disadvantage in the fact that the Board of Education is political in its nature. However, the advantages of the system as a whole far outweigh its weak points. Concerning the question whether it would be better to have private architects engaged to design new school buildings, Mr. Mundie states that, after five years' work as architect to the Board, he concludes the system in use is preferable, though formerly he favored the plan of employing outside architects. The scope of the work is too large, and its detail too complex to allow of harmonious and satisfactory results being secured if eight or ten in-

dependent architects are in charge of as many different buildings, with no harmonizing influence but their common employment by a non-technical and inexperienced board.

THE RELATIONS OF SPECIALISTS TO ARCHITECTS.

Two papers were presented on the relation between architects and the technical experts who are required in modern building design. One of these papers, by Mr. Corydon T. Purdy, reprinted in our last issue, related particularly to the structural engineering in building work, the designing of steel framework foundations and the like. The other paper, by Mr. E. V. Seeler, refers to specialists more generally. The author says that less trouble arises with the engineer than with other specialists, such as landscape architects, window designers, interior decorators, etc. He then emphasizes the importance of keeping the work of all the specialists in subordination to the central control of the architect. The means by which this result is to be reached in the best manner are thus expressed:

The only guarantee of the perfect working out of these various parts in the makeup of a building lies, first, in the education of the architect whereby he himself is competent to conceive, to express and to execute, or to select from around him those who can do so; and, second, in the untiring supervision of his executants.

An interesting side of all this is that the intelligent specialist, whatever his work, is usually willing and desirous that general lines shall be laid down for him. He knows that his work gains in dignity, grows more interesting in variety, and helps more in the accomplishment of a unified result than would be possible under any other circumstances.

There is no reason in the world, other than deficiency of some sort on the part of the architect, why the architect and the specialist should not work side by side in entire harmony under the acknowledged leadership of the architect and the willing acquiescence of the specialist.

TALL OFFICE BUILDINGS.

A paper on "Financing Building Operations," by Mr. W. H. Russell, describes various methods in current use in large cities to secure the capital required for building work; but the paper is more interesting in its concluding portion, which makes a suggestion regarding the artistic design of tall buildings, as follows:

Assume, for instance, that it is proposed to finance the construction of a high office building in some great center. To ensure a good income the requirements, above the first or second story, would probably be to have as many windows as possible, not too large to be easily operated, and yet as large as practicable. Each window should be separated from each other window, preferably by masonry, as it is advisable to have as little steel as possible exposed to the elements; but steel thoroughly covered with cement masonry is supposed not to deteriorate. Projections over adjoining property should be dispensed with to avoid legal complications. Many title guarantee companies discriminate against such encroachments. A large cornice is a disadvantage to windows under it. Therefore the requirements which confront the architect are a flat wall pierced with windows at equal intervals, like a waffle iron and not even relieved by a large projection.

Although this is a difficult proposition, it is certainly a very interesting one. The high building is essentially American. It is a new proposition and requires more originality to solve than a problem where some historic example from the Old World may be taken as a prototype.

Would it not seem as if these requirements might best be met by the clever application of colors? If some one could use bright colored terra cotta, for example, omitting large projections but with a handsome sky line, and make a beautiful building, he would indeed deserve the thanks of the community. For the skyscraper has come to stay, and the business centers of our large cities will be rebuilt.

The Egyptian, Greek, Roman, Romanesque and Gothic architects all felt the want of color and used it, and although color had perhaps better not be suggested by an architect until he is quite sure that he will be employed, it seems to be a subject for serious consideration.

Two papers on "The Selection of an Architect for Government Work by Competition" were presented by Mr. J. P. Jamieson and Mr. I. K. Pond, respectively. The general sentiment of architects appears to be against competitions as a regular system for selecting an architect, as well in government as in private work. The two papers in question concerned themselves more with methods of conducting government competitions to secure the best results than with argument on the abstract question. They are therefore of restricted interest. The same may be said of a paper by Mr. Grosvenor Atterbury, on "Office Organization." In discussion on this latter paper, Mr. W. A. Swasey related a case in which he had attempted to exercise his contract privilege of discharging the contractor's foremen on a building for incompetence and delaying the work. His attempt failed, apparently because he was not willing to employ the injunction procedure to remove the man from the building site. In consequence of this "ignoring the architect's authority," the work in question was delayed beyond the contract time for completion. Mr. Swasey cited the case in order to bring out the need for very definite general clauses in the contract specifications. It will be recognized that similar instances are not infrequent in purely engineering work.

An illustrated lecture by Mr. F. M. Day, "Progress in Municipal Work," presented a review of work, mainly European, in advancing civic beauty and municipal planning.

A number of American and foreign gentlemen were elected Honorary Members or Corresponding Members of the American Institute of Architects. They are:

Honorary Members: Channing Seabury (St. Paul, Minn.), William Barclay Parsons (New York, N. Y.), Alexander J. Cassatt (Philadelphia, Pa.), Elihu Root (New York, N. Y.), Pierre Jerome Honore Daumet (France), Richard P. Spiers and George F. Bodley (England), Gabriel von Seidl and Friedrich von Thiersch (Germany), and Ricardo Velazquez Bosco (Spain).

Corresponding Members: Edwin L. Lutyens (England), Josef M. Olbrich (Austria), Jose Urioste y Velada, Enrique Repulles y Vargas, and Luis Cabello y Lapiedra (Spain), Henri Deglane and Gaston Fernand Redon (France).

EDWARD SHERMAN GOULD.

Edward Sherman Gould, M. Am. Soc. C. E., one of the prominent hydraulic engineers of this country, died suddenly of pneumonia at the Hotel Aldine in New York City on January 24.

Very faithfully yours
E. Sherman Gould

Mr. Gould was born in the City of New York on August 13, 1837. He was the son of the late Edward S. Gould and Mary E. (Du Bois) Gould, and he was the grandson of Judge James Gould, of Litchfield, Conn., and of Cornelius Du Bois, of the old New York family of that name. Mr. Gould received his professional education in France at the Ecole des Mines, St. Etienne, and from 1862 to 1865 he was Secretary to the Hon. John Bigelow, then Consul-General of the United States at Paris.

Returning to the United States in 1865, Mr. Gould at once commenced the practice of his profession in the employ of several private companies interested in the development of water-works. From 1873 to 1876 he was a U. S. assistant engineer under the late General Q. A. Gilmore, Corps of Engineers, U. S. A., then in charge of river and harbor works and fortifications on the South Atlantic Coast. From 1877 to 1886 Mr. Gould was in the employ of the Department of Public Works of the City of New York, and of the new Croton Aqueduct Commission. He was engaged on surveys and construction of the Bronx [illegible] water supply and was a Division Engineer on the new Croton Aqueduct.

In 1886-90 Mr. Gould was employed at Scranton, Pa., designing and building the works connected with an increased water supply for that city. The excellent manner in which this enterprise was devised and carried out—taken in connection with his long previous experience—established Mr. Gould's reputation as a hydraulic engineer and he thereafter devoted himself to private practice as a designing, supervising and consulting engineer. In 1890 he went to Havana, Cuba, to take charge of the building of the new water works for that city, as engineer representative of the American contractor, Messrs. Runkle, Smith & Co. This work was successfully completed in 1894. Between 1894 and 1898 he was engaged upon various engineering works, visiting Mexico and Venezuela in this connection.

On the breaking out of the late war with Spain Mr. Gould was temporarily on the staff of the late Gen. William Ludlow, at army headquarters, at Tampa, Florida. He was employed in a civil capacity to give aid and information in connection with the proposed expedition to Havana, and his knowledge of Spanish and his familiarity with the topographical situation of Havana made his services peculiarly valuable in this connection. At the close of the war Mr. Gould returned to Havana and was for some time engaged in railway operations for the American Indies Co., of 100 Broadway, New York.

In addition to the work specified, Mr. Gould has been employed as a consulting engineer upon a large number of engineering works, and at the time of his death he was engaged in planning an improved water supply for the city of Monterey, Mexico, having visited, examined and reported upon this improvement in the latter part of 1904.

Mr. Gould has contributed much valuable matter to the technical journals in the line of his favorite studies, and his frequent contributions to the columns of Engineering News have made his name well known to our readers. He was the author of "The Elements of Water Supply Engineering," an exceedingly useful and well conceived compendium of modern hydraulic practice. He also published "A Primer of the Calculus," "Practical Hydrostatics and Hydrostatic Formulas," "High Masonry Dams," and a series of standard specifications for dams and reservoirs.

Mr. Gould was a man of charming personality, and his many friends will deeply regret his sudden death. He was made a Member of the American Society of Civil Engineers Nov. 4, 1885; he took a very lively interest in the affairs of this society, and contributed about eighteen papers to its Transactions. He long resided in Yonkers, N. Y., having married Miss Arabelle Duncan Ludlow, daughter of Dr. Edward Greenleaf Ludlow, of New York. Mrs. Gould, two sons and a daughter survive him. His eldest son—Edward Ludlow Gould, a young engineer of brilliant promise—died a few years ago. At the time of his death Mr. Gould was a member of the committee appointed by the Mayor of Yonkers to assist in the plan for the elimination of grade crossings on the New York Central & Hudson River Railway within the limits of Yonkers. Mr. Gould received from the Venezuelan Government the decoration of El Busto del Lavertador for services performed for that government.

HICKORY-WOOD STRAIN INSULATORS are recommended by Mr. W. B. Potter, of Schenectady, N. Y., for overhead work of electric railways when line potentials higher than the usual 500-600 volts are to be handled. The insulator consists of a straight round stick turned from a piece split out of straight-grained hickory. The ends are expanded in taper collars, which give attachment to the wire on either side. The wood is thoroughly waterproofed with oil before being put in place. For trolley-line work at 2,200 volts the stick would be about 20 ins. long between collars. The advantages of this form of insulator are: strength without brittleness; the same design for various voltages, the length of stick being the only variable; very long creeping distance; absence of danger of heating and softening; and cheapness.

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The use of salt water for fire protection is quite common in Great Britain, but is rare in America. All the more interest, therefore, is attached to the three such systems in use at U. S. Navy Yards, and the fourth one about to be installed at a U. S. Naval Station, all of which are described elsewhere in this issue. There is reason to expect that such systems will be adopted in the future by many seaboard cities hard pressed to secure ample supplies of fresh water under adequate pressure.

A very interesting story, from a metallurgical standpoint, was related in the course of a recent discussion in the Engineers' Society of Western Pennsylvania. We quote from the printed "Proceedings" as follows:

> Mr. Moore*—We had occasion to make a forging about 10 ins. in diameter and 12 ft. long. After turning it the machinist took a cold chisel and cut off the center; I happened to be looking at him and saw him throw his head back quick and say, "There is something coming out of that shaft." I smelt something right away. I told him to light a match and he did so, and that thing burned for ten minutes. I tired it. I would like to ask somebody if they can tell what that was? Was it a gas that had accumulated in the center of that shaft?
>
> Mr. R. A. McDonald†—That in many cases is common, but you seldom hear of it. They don't usually tell things of that kind. But in experimenting, lots of ingots have been tested by drilling under water, and when you come to cavities gas escapes, causing bubbles. I have seen large ingots made by the open-hearth process that you could stick your hand in the center of them after they have been forged. Now to make a cavity there has got to be something in it. You often get a cavity down in the center or bottom of the ingot. They are in all shapes and sizes.

In all the literature concerning blow-holes in steel, we do not recall anything that matches the above. A cavity containing enough gas to keep a jet lighted for ten minutes must have been a pretty fair sized cave. It is a pity the later history of this remarkable forging is not recorded, for one is curious to know what dissection of the piece revealed, since surely after such behavior the piece must have been cut up for scrap. The earlier history of the piece would also be of interest to know what sort of an ingot it came from and how much of the top end was sacrificed. It is not so long ago that we heard a rail specification which required rejection of a considerable per cent. of the ingot objected to on the ground that steel makers nowadays knew their business so well that blow-holes gave very little trouble. From the above remarks it would appear that blow-holes do still occur, and that precautions against flaws due to their presence in finished steel are still as necessary as ever.

In reply to the above query as to what the gas was which had accumulated in the blow-hole, Howe's "Metallurgy of Steel" states that the gas found in blow-holes in steel ingots after cooling is a mixture of nitrogen and hydrogen.

A cleaning-up clause is frequently omitted from specifications involving a small quantity of work, but such an omission, small as it may be in point of dollars involved, often leads to trouble. A correspondent sends us a copy of specifications for bridge abutments to illustrate how a small omission may lead to an irritating dispute. He says:

> The contractor, in excavating for the abutment foundation, deposited the dirt in the stream to form a dam to carry the water around and past his work. After the abutments were completed the contractor claimed that he was not obliged to remove the earth that he had placed in the stream, as he had done all the work required to construct the abutments according to contract. I claimed that the stream should be left in its original condition. A few words in the specification would have prevented any controversy.

This illustration serves to call attention also to the spirit of resistance on the contractor's part that so often manifests itself on contract work. We wonder whether contractors realize fully how cents wise and dollars foolish is the policy of always refusing to do what is not specifically required in the letter of the contract, regardless of whether it is a naturally implied part of the work. The contractor who is always alert to detect omission, with a view to getting an "extra," becomes in time so heartily disliked by engineers that he is never requested to bid on any private work, while on public work he is apt to receive the label of "public nuisance," with all that goes with the term.

Among those details of structural steel work which demand and should receive special care in planning and construction, it is proper to include the fastening of columns to their foundations. In many cases of design vital dependence is placed on the strength of this fastening, the anchorage; thus, a column which experiences uplift, or one which for economy is calculated as "fixed" at its base, must be thoroughly anchored if it is not to menace the safety of the superincumbent structure. In other cases, where the anchorage has only secondary functions, it yet has a large emergency value, and under unusual circumstances may become responsible for the safety or fall of the structure. In both cases careful attention to the anchorages would seem to suggest itself quite naturally.

In this view it is surprising, even a little startling, to notice that in two recent bridge accidents defective anchorage of columns was exhibited. On Aug. 20, 1904, a tornado blew down part of the Smith Ave. bridge at St. Paul, Minn., a high bridge supported on steel towers. The public discussion of the accident in our pages brought out the fact that, in the main tower involved in the fall, one of the windward columns lacked the nuts which belonged (and probably had at one time been) on its anchor-bolts. Engineering opinion is not altogether agreed in its analysis of the causes and mode of this collapse, but there is no reason to doubt the statement that the ultimate resisting power of the bridge at the point of failure was seriously reduced by the absence of the anchor nuts. More recently, on Dec. 29, 1904, a runaway street car knocked out a viaduct post under the South 22d St. bridge in Pittsburg, Pa. It was found that the anchor-bolts in the base of this post were so short that they did not project far enough above the base to take nuts and in consequence had never been fitted with nuts. From the description of the accident, given elsewhere in this issue, it may be concluded that the column would have been wrecked even had the anchor nuts been in place. Yet, in possible emergencies of other nature or degree, these missing nuts might have been directly responsible for failure of the post or of the whole bridge.

Whatever the relation of the defective anchorages to the two accidents in question, there is ground for reflection in the very fact that they were defective. Important as column anchorages are, and unfavorably located as they are, they are none too good even when thoroughly well made. A little carelessness in an anchorage, though it may not form a direct source of danger, can neutralize a great deal of painstaking design and much well-applied metal in the superstructure. Both safety and economy speak for care in anchorage construction. We trust it may be found that the two instances of defective anchorages above cited are rare exceptions, and that ordinarily this detail of structural work receives the attention it deserves.

While speaking of anchorages we would claim attention for another phase of the subject, namely: the rigidity of a column anchorage. In recent months our correspondence columns have brought some interesting discussion of stresses in knee-braced mill-buildings, the last contribution to which appeared only last week. In this discussion, looking aside from some aberrations of reasoning, considerable difference of opinion was apparent on the question of what assumptions should be made in analyzing a knee-braced mill-building. The question is important, particularly for this reason: While such a structure is in type a fixed-end arch, yet there is probably greater arbitrariness and error in treating it by the elastic-arch analysis than in treating it by approximate methods similar to those employed for portal-bracing. The latter appear to be the best and most precise methods which we have for the analysis of the problem. But in this analysis, everything depends on carefully chosen assumptions as to distortion of columns, of trusses, etc. The general consideration of these assumptions is too broad for the present moment, but we wish to refer to the assumptions concerning the column base. It is generally assumed, in such a building, that the base is "fixed," that is to say equivalent to encastré. If the base were pin-jointed, or if it were slightly rotatable under bending moment, then the point of contraflexure in the column would lie much lower than with fixed base, and correspondingly the bending stress in the dangerous section would be greatly increased. It is not at all evident that the ordinary mill-building column is rigidly fixed at its base. The likelihood is that some inelastic motion, and considerable elastic motion, occurs at the base when the column experiences lateral forces; if this is so, then the column stresses are probably greater than they are ordinarily computed to be. This whole matter depends on the rigidity of the column anchorage, in which field, we believe, there exists no definite experimental information.

Some of our large bridge works should find it easy to obtain some experimental evidence in this point. An extensometer apparatus such as is used to measure stresses in bridge members would answer as a test instrument. By applying such an apparatus to the flanges of a column close to the base, the actual column moments for various lateral forces applied at the top of the bent could be measured. Simple calculation from these tests would then suffice to express the rigidity of the base against overturning distortion.

CONCERNING SPECIFICATIONS FOR SAND.

Probably ninety-nine per cent. of the specifications which are written to-day for concrete or masonry require the use of "clean, sharp sand." Is it not time the question was raised, what justification, if any, exists for these requirements? The engineer who writes the specification will acknowledge, if he is frank and honest, that he calls for clean, sharp sand simply because specifications have always been written that way.

It is, in fact, an inheritance from the days of lime mortar. Engineering text-books of a former generation used learnedly to explain that sand made up of angular grains exposed so much more surface to the lime that the process of formation of calcium silicate in the mortar would be much more rapid than if rounded grains were used. It was also claimed that the lime would adhere to a rough surface better than to the smooth surface of water-worn sand grains.

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†Manager Crescent Steel Works.

But because the grandfathers with their limited knowledge did things in a certain way is no reason why their descendants in the 20th century should follow the same way. Is there then any good reason for requiring "clean, sharp sand" in writing a specification for mortar or concrete?

We gave a partial answer to this question a little more than a year ago in our issue of Nov. 19, 1903, in a paper by Prof. C. E. Sherman, of Ohio State University. In that paper tests were described of sands mixed with various percentages of loam and clay. These tests showed that a mixture of 5 to 15 per cent. of such materials with sand made a briquette rather stronger than one made with perfectly clean sand.

In this issue we follow up this subject with a paper by Mr. J. C. Hain, Engineer of Masonry Construction of the Chicago, Milwaukee & St. Paul Ry., who reports a large number of tests of the sands actually used in masonry construction on that great system. He shows that sands containing clay and even those with large percentages of rich top soil are no worse and often better than clean sand. Engineers generally prefer coarse sand, but Mr. Hain tried sand which was actually finer than ground cement and it gave very satisfactory results. Most surprising of all, perhaps, were the results obtained with a sand containing microscopic, easily crushed, fossil shells. This showed such satisfactory results that it was used in building a concrete pivot pier for a drawbridge.

In view of the results obtained by Mr. Hain, is it not quite time that engineers stopped and asked why they are still writing specifications for "clean, sharp sand," and not only writing specifications but insisting on their observance. With a show of seeming wisdom an inspector may often be seen grating a pinch of sand near his ear, or squinting at it through a pocket lense to determine its sharpness. The writer recalls several instances where a really good sand was rejected because it did not sound sharp enough to suit the inspector, the result being that sand had to be obtained at a greater expense because of a longer haul.

Let us be frank enough to confess that this is all a matter of ignorance and prejudice; that practically the difference between sharp sand and sand with rounded grains is a matter of tweedledum and tweedledee; that the old prejudice in favor of bank sand and against river sand is a prejudice and nothing more; that a specification requiring "fresh water" sand, in view of tests which have shown no injury due to the use of salt in mixing mortar in freezing weather, is a specification of no advantage to the work, unless it is a work where appearance is a factor and it is desired to reduce the chances of efflorescence.

We are aware that many engineers will reply to this that where clean sand can be obtained as cheaply as anything else, it is just as well to specify it since it involves no additional expense and the results are known to be absolutely satisfactory. There is a surprisingly large proportion of engineering works, however, where a supply of clean sand does mean a greater expense, involving a haul of perhaps several miles or even several hundred, as in the cases cited by Mr. Hain; or perhaps involving washing of the sand. If the engineer can save this expense, will he not show his deficiency in business acumen if he fails to do so?

What, then, is a proper specification for sand? Why should we call for coarse sand when we know that a sand of assorted sizes takes less cement and makes a stronger mortar? Why should we call for clean sand and jealously pick up a handful to see if any dirt is left to soil the hand, when we know that a considerable percentage of dirt does no harm whatever to the strength?

The proper requirement for a sand specification it seems to us is a requirement of results. Specify that the sand must make a mortar as strong as that made with perfectly clean sand. If there is any doubt, an inspector can mold some rectangular briquettes in a few minutes with both kinds of sand and can rig up from an ordinary platform scale a testing machine to break them transversely. If the work is of such a character that a large surplus of strength is unimportant, then accept a sand which will show at least a certain percentage of the strength of a standard clean or washed sand. On the other hand, if the appearance of the finished surface is a matter of importance, then it is unquestionably proper to require a particular sand to be used, to require it to be clean, or to be washed if necessary, and to require that it shall be uniform throughout the work so that all parts of the finished surface shall be uniform in color. In any case, it is proper to require, as Mr. Hain points out, that a sand containing silt or clay shall have it uniformly distributed through the mass, and not concentrated in pockets.

Already some progressive engineers are altering their specifications and instead of requiring "clean sand," they specify that the sand shall contain not more than a specified percentage of foreign matters. A specification for a work in Arizona on the U. S. Reclamation Service which came to our notice this week has the following clause relating to sand.

> The sand must be free from organic matter and must not contain more than 10% of clayey matter. All the sand must be of such size as will pass through a screen with ¼-in. square mesh and shall be of a mixture of sizes satisfactory to the engineer.

That a mixture of sizes and not a uniformly coarse sand gives the best and most economical results in making mortor and concrete is a fact which engineers are just beginning to fully appreciate. The inevitable result of such tests as those of Mr. Hain will be to encourage engineers to experiment with materials heretofore supposed to be wholly unsuitable for use in masonry construction. With the advent of machine mixing, too, engineers are learning that they have been paying great sums for cement in the past which was actually not needed to fill voids in the aggregate but only to make up for the deficiencies due to insufficient mixing. We have now learned that sand need not be clean or sharp or coarse to make good mortar, and that great quantities of finely crushed stone, which has been thrown away from the rock crushers working on concrete materials is as good as the best sand for making mortar.

One thing still undetermined, however, is the influence of foreign matter in sand upon its cement carrying capacity. In a great many engineering works where mortar and concrete is used there is no particular advantage in such great strength as a 1 to 3 Portland cement mortar gives; hence the engineer, if assured of a thorough mix, can use a mixture of one cement to four or five or six of sand, or even more. The question is now, what results a sand containing clay or loam will give in such lean mixtures compared with a pure sand.

There are large sections of the country where the scarcity of coarse clean sand and the entire absence of gravel or stone deposits make this question one of very great importance in connection with the manufacture of concrete blocks, concrete bricks, sidewalks, etc. Mr. Hain's experiments give encouragement that concrete in such localities may be made of better quality with local materials than has hitherto been deemed possible. There will not be wanting engineers, we are sure, to test the possibilities in lean mixtures made with these sands.

LETTERS TO THE EDITOR.

The Littoral Drift on the Long Island Shore and the New York Harbor Entrance.

Sir: An article in "The Scientific American," entitled "The New York Harbor Entrance," by Prof. L. M. Haupt, sounds an alarm for the welfare of the port. The following point, however, seems to be overlooked:

At the present time there are across the wide submerged flats between Coney Island and Sandy Hook several channels of moderate depth. The article shows that Rockaway Beach is traveling westward, and Sandy Hook northward across this area, thus narrowing the entrance.

As the channels are created and maintained by the tidal flow, may we not look for a single, much deeper and better channel after the above narrowing has taken place? In other words, is not the approaching catastrophe, pointed out by Prof. Haupt, a blessing in disguise, but not wholly unrecognizable?

Very respectfully, Cassius E. Gillette,
Major of Engineers, U. S. A.

San Francisco, Cal., Jan. 21, 1905.

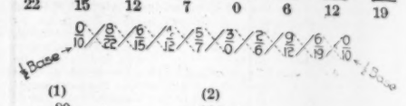
(Prof. Haupt claimed in his paper, above referred to, that a large body of sand is moving westward along the southern shore of Long Island while the littoral drift northward along the New Jersey Coast is bringing another huge volume of sand toward the same point. He contended that this sand will inevitably choke up the new 40-ft. Ambrose channel entrance to New York Harbor, now being dredged at a cost of some $5,000,000.—Ed.)

Another Method of Calculating Cross-Section Areas.

Sir: In your issue of Jan. 19, 1905, I notice a method of calculating the area of cross sections. Perhaps the following method will prove of interest.

Example: Base, 20 ft.; side slopes, 1½ to 1. Cross-section notes as follows:

−8	−6	−4	−5	−3	−2	−9	−6
22	15	12	7	0	6	12	19



(1)	(2)
80	120
132	72
60	28
60	54
21	72
18	
24	346
171	
60	
626	
346	
2 | 280	

140 sq. ft. area section.

1st, multiply numbers connected by solid lines, result column (1).

2d, multiply numbers connected by dotted lines, result column (2).

3d, subtract sum of column (2) from sum of column (1).

One-half the remainder is the area of the section.

Yours respectfully,
H. A. Dawley, Engineer, Southern Ry.

Louisville, Ky., Jan. 20, 1905.

Should Our Government Relinquish its Rights to the "Maine"?

Sir: Your excellent article in Engineering News of Dec. 8 in reference to raising the battleship "Maine," lying fast on the bottom of Havana harbor since February, 1898, contains much that makes it valuable. The loss and possible restoration of this ship has always appealed to the highest regard and patriotism of many ex-soldiers and sailors of two wars, and to Americans generally. When it was reported last fall that this famous wreck had practically been turned over to a company of Cuban contractors who advertised to use it as a matter of speculation, the transaction and purpose seemed so contrary to unmistakable public sentiment that the attention of the President was called to the report. A letter was sent to him respectfully requesting that special legislation be recommended in reference to raising or floating the "Maine" by the Government itself. It appears that our communication was turned over to the Secretary of the Navy, who kindly replied as follows:

Navy Department, Washington, Nov. 30, 1904.

Sir: This department has received by reference from the President, to whom it was addressed, your letter of the fourth instant, suggesting special legislation for the removal from Havana harbor of the wreck of the "Maine." In reply I have to state that it may be that special legislation will be required if it is deemed necessary to make final disposition of what remains of this vessel. A recent suggestion, however, which has been the subject of correspondence with the Department of State, is that the matter be adjusted by treaty with the Cuban authorities, subject to confirmation by the Senate.

Very respectfully,
Paul Morton, Secretary.

From this letter from Secretary Morton we are led to think, and earnestly hope, that the Navy Department did not "give up the ship," and will not until after the question is finally passed upon by Congress with due regard for American patriotism. Alfred King.

Arlington, N. J., Jan. 20, 1905.

The Right to the Title of Engineer.

Sir: I am most desirous of obtaining information from you or the readers of Engineering News regarding the responsibility and legal standing of a man who declares himself, by signature or otherwise, to be a Civil Engineer. Mut he be a person to whom such a degree has been given by a college or university?

This is becoming a matter of great magnitude, and should be brought before all civil engineers for serious consideration.

Faulty construction, misrepresentation in proposals and specifications, as to quality, quantities and conditions, etc., through lack of ability, ignorance or neglect of proper investigation, and many other defects in design

construction may often be traced to men who pose as civil engineers, who have neither degree nor ability to practice in the position of a civil engineer.

Yours respectfully, Subscriber.

New York, Jan. 16, 1905.

(If our correspondent will search through back volumes of Engineering News, he will find repeated discussions on the general question which he raises. As a matter of fact, any person may call himself a Civil Engineer or any other kind of an engineer and do business or attempt to do business as such. To restrict the use of the term to those who have received it as a degree from some school would be wholly impracticable because of the very great number of engineers who have gained an education in the stern school of experience which has made them as competent as many of the graduates from the foremost schools. Besides, where should the line be drawn between the schools whose degrees should be recognized and the schools which give only a superficial smattering?—Ed.)

Rough and Ready Methods of Letter Copying.

Sir: I was much interested in the letter from Mr. E. P. Osgood (p. 41, Eng. News, Jan. 12) describing an emergency letter press, as it revived memories of the antics I used to cut in treading my letter press book; but I do not understand why he wets the tissue page the second time. I used to get good copies by wetting the tissue page and laying the letter to be copied on the wet page, all just as if the book were going to be used in a press.

But that was not what I started to write about. I have been using for years a copying book made by Alvah Bushnell, corner of 13th and Market Sts., Philadelphia, which combines press and book in one, and it consists of a tissue paper book bound in flexible covers, with a wooden roller tacked along the back.

To copy, write the letter with any good copying ink, but I prefer (and have not used anything else for years) a copying pencil. Place the letter to be copied upon a sheet of manila paper, beneath the leaf of the copying book on which the copy is to be made, then place a wet (not too wet) cloth (muslin) upon the leaf which is to receive the copy, and cover the wet cloth with another sheet of manila paper. Close the book and roll it up tight in the hands, holding it firmly a few seconds, and the result will be equal to anything obtained in a press. The manila sheets and muslin are furnished with the book.

When the book is filled the roller is removed by drawing the tacks, and the book can then be filed away flat.

The damp cloth should not be returned to the book, the traveler will find a small tin box very handy to keep the wet cloths in.

I have copied as many as twelve letters at once with this device.

I am not writing this as an advertisement, but to bring to the notice of brother engineers a copying book that will surprise and delight them, as it has

Yours truly, Alonzo G. Collins.

305 Oakland Ave., Pittsburg, Pa., Jan. 13, 1905.

(A sample tissue sheet inclosed with the above letter shows very satisfactory results.—Ed.)

The Failure of the Charleston Suspension Bridge.

Sir: Commenting on the description of the Charleston bridge failure, by H. G. Tyrell, in your issue of Jan. 5, the writer begs to make a correction in the otherwise exact and comprehensive account of the original construction and present condition of that bridge.

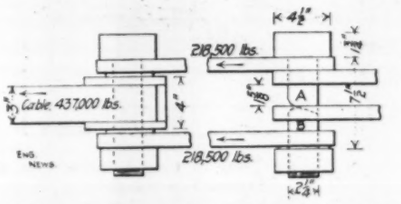
Mr. Tyrell says that the immediate cause of the failure was the rupture of one wire cable within the anchorage, and, in consequence of it, the shearing off of a pin in the anchor chain of the other cable, after double the stress was thrown upon the same.

The fact is, that the pin did not shear off at all, but it broke exactly at the place of its greatest bending moment. In the absence of testimony from eye-witnesses, it is impossible to say whether it was the cable or the pin that broke first, the facts merely proving that in one cable the wires were stronger than the pin, and in the other the pin stronger than the wires. There are, however, several reasons which make it very probable that the pin broke before the cable.

The original strength of each cable, as ascertained by the writer through tests with a number of wires taken from one cable, was 437,000 lbs. A glance at the adjoining sketch and a simple calculation will at once show that the pin, looking at it even in the favorable light of a beam fixed at the ends, should have had a diameter of at least 3¼ ins. in place of 2¼ ins.; hence its bending resistance was three and one-third times smaller than the ultimate tenacity of the cable. In other words, if the cable was subjected to one-fourth of its breaking strength, which is a tolerably large factor of safety, the pin came already near the point of rupture.

It is true the wires of the cable around the shoe were badly corroded and considerably diminished in strength, but the writer found enough sound metal in the broken sections to make him believe that the strength of the cable, where it broke, might still have been one-half of its original strength. Tests, made by the writer at former opportunities, have shown that badly corroded wires have still a remarkable resistance to a steady pull, while the slightest bending or a shock will break them as easily as matches. It is therefore, probable that, for a steady pull, the cables were stronger than the pins, and would not have broken if none of the latter had failed.

The appearance of the broken pin indicates the possibility that the rupture was an old one, and that the inner links were suspended from the projecting ends of the pin until the stress became too large, which caused the links to squeeze themselves through the opening made by the rupture. This is shown by the ruptured sections being more or less polished, and their edges rounded off. Only about one-quarter of the section of the longer end (marked A in the accompanying sketch), and three-quarters of that



Sketch Illustrating Probable Manner of Failure; Anchorage of Charleston Suspension Bridge, Charleston, W. Va.

of the shorter end (B) of the pin shows a crystalline fracture, while the rest of the section looks as if it had been filed, evidently caused by the action of the links when they were squeezed between and through the two portions of the pin.

When one cable with the broken pin flew out of the anchorage, the adjoining cable received necessarily a severe shock, easily breaking the corroded wires, which possibly might have withstood the increased tension if the latter could have been applied gradually.

There is no radical error in the original design of the bridge, except that the anchor pins were too small, a defect which is inherent in most ancient structures. But there was certainly a great negligence in not having the bridge properly inspected and the wires of the cables protected against corrosion.

Wilhelm Hildenbrand, C. E.

New York, Jan. 21, 1905.

Notes and Queries.

E. S., Baltimore, Md., calls attention to an error in the formula for computing sinking funds, printed on p. 288 of our issue of Sept. 29 last. The formula should read:

$$\frac{A}{C} = \frac{r^2 - 1}{r^{2n} - 1}$$

In describing the trunnion bascule bridge over the Chicago River at North Western Ave., in our issue of Jan. 19, it was stated by mistake that the shop work was done by the American Bridge Co. As a matter of fact, the structural material was furnished by the Pennsylvania Steel Co., and the machinery by the Allis-Chalmers Co.

SURVEYING IN THE CITY OF CHICAGO.*

By S. N. Howard.†

The placing of public improvements, street pavements, sewers and the net work of pipes which underlie our streets, has destroyed every section corner monument in Chicago except, possibly, a very few in the outskirts of the city. The stakes marking the lines in the older subdivisions soon rotted away or were replaced by fences or buildings more or less accurately placed on the line, and these probably several times renewed. The conditions being such, the only thing left for the surveyor is to depend on occupation. He accordingly runs the lines of the streets bounding the block in which he is to operate by such buildings or marks as he may have noted in former surveys or such as may appeal to his judgment. If he runs the line for any considerable distance he will undoubtedly find that some of the buildings, and marks of other surveyors (and possibly some of his own) are not in line.

In establishing interior lines, the rule of course is to divide the actual measurement of the block in proportion to the record of the several lots; but in most cases we find that all of the occupation does not agree with the proportion, possibly only a small portion of it. In this case the surveyor places the line where, in his judgment, it will best harmonize with the general occupation, work the least injury to all parties concerned, or will be upheld by the courts, should the case reach them.

Occupation, therefore, cuts a large figure in city surveying, and if long enough continued establishes that particular line without question. Even in cases where the surveyor may have evidence that lines were established in a way differing from the bulk of the occupation, it may be better to acquiesce in the erroneous location and thus prevent the plunging of neighborhoods into quarrels and litigation.

In the later subdivisions, where there are still original stakes standing, or where permanent buildings have been erected in conformity with the original stakes, there is comparatively little trouble. It is often found, however, that lines which have been marked or notched in the cement sidewalks are not stable. The walks move and the marks go with them.

The usual requirements of the architect as to surveys are as follows: Lines, grades, angles, location and elevation of sewer, elevation of walks in front of lot and adjoining the same and elevation of ground; and sometimes in addition is the size and location of water, gas and electric mains; the location of point where water, gas and electric service pipes come through the curb; location of house drains; the location, height and plumb of adjoining buildings; thickness of party walls at the several stories, and location and depth of the foundations of the same.

The bench marks of Chicago were in a chaotic state until a few years ago when steps were taken to establish permanent bench monuments. Uniformity is now being gradually evolved through the use of these monuments and of intermediate benches, made by the City Bench Engineer, which benches are accessible to the surveyor. Street grades are also getting into better shape through the efficient work of Mr. W. H. Hedges, the Grade and Bench Engineer of the Department of Public Works. An accurate record is kept of the date of all ordinances establishing grades, new grades are being established, and old grades are changed to agree with existing walks whenever differences are brought to the attention of the department.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors; Chicago, Jan. 18-20, 1905.

†Secretary of The Greeley-Howard Co., Opera House Block, Chicago.

SOME TESTS OF IMPURE SAND FOR CONCRETE.*

By J. C. Hain.†

Allow me briefly to explain the conditions which led to these tests. The Bridge Department of the Chicago, Milwaukee & St. Paul Railway Co., Mr. C. F. Loweth, Engineer and Superintendent, with whom I am employed in charge of the masonry, requires large quantities of sand in its substructures and culverts, which are principally built of concrete. In the last six years, we used a maximum per year of about 85,000 barrels and a minimum of about 50,000 barrels of cement. This will give you an idea of the amount of sand required yearly. The sand comes from numerous sources over the entire system of 7,000 miles, most of which are company sand pits. The problem before us was one of selecting the most suitable sand with the least haul. This led to laboratory tests of questionable sands. In many instances these tests were a great surprise to us. I will call your attention to some of the most peculiar of these.

Before doing so, I will briefly explain the tests. A 1 to 3 mixture was used throughout except where neat cement is specified. Each tensile test represents the average of three briquettes except in cases where one appeared exceptionally irregular, in which case it was thrown out. The different sands are grouped in the tabulation because each was tested with a different lot of Portland cement, as well as a different sample of the St. Paul standard sand. For these reasons, not only the test in pounds is given, but also the percentage any test is of the corresponding standard test. Thus the percentages give a basis of comparison between the sands of different groups. The neat tests are also shown for comparison. All tests were extended to three years. Those not shown are still to be made.

One of the early questionable sands which needed our consideration, was a bank sand of glacial deposit, found near Elkhart Lake, Wis., tests of which are tabulated. On first observation, its fineness seemed to be the greatest objection. It contained some coarse particles, but the fine ones were in excess; 92% passed through a No. 24 sieve and 28% through a No. 50 sieve, while only 54% and 11%, respectively, of the St. Paul standard passed through these same sieves. In other words, on these two sieves, Elkhart Lake sand showed up twice as fine as the standard. However, on closer examination, a more striking peculiarity developed, which seemed even more objectionable than its fineness. Apparently the sand bank was a deposit of broken shells, because it could be easily ground into very fine particles by rubbing between two hard objects. When examined under a microscope it appeared to consist of fine grains of silica with rounded smooth surfaces, mixed with larger particles of softer material with sharper corners, which probably consisted of shells or a soft limestone. (Evidently the silica crystals had been worn round and smooth before the shell-like mixture was added). While the larger chalk-like particles seemed to be soft, the silica was also easily crushed, but not so readily. When treated with hydro-

*A paper read at the meeting of the Cement Users' Association at Indianapolis, Jan. 17-19.

†Engineer of Masonry Construction, Chicago, Milwaukee & St. Paul Ry., Chicago.

chloric acid it gave off a strong effervescence, indicating that we were probably correct in the supposition that it contained shells or limestone.

We had a particularly important job in the near vicinity where we wanted to use this sand, because this was the only available pit for several hundred miles. Though sand from this pit had been used for building purposes for years, the question arose whether we were safe in using it for the concrete center-pier of a draw span. A laboratory test was made in connection with our St. Paul standard sand, for comparison. The results are shown in the table. While the Elkhart Lake sand tests vary from 60% to 99% of the standard, it averages throughout the tests up to two years, about 73% of the standard, which is a very good showing, considering everything. To make the comparison clearer, Ottawa sand, which was favorably recommended by the American Society of Civil Engineers as a desirable standard, developed an average strength of 80% of our standard, up to two years. From this it appears that the fine shell-like sand from Elkhart Lake differs only by 7% from the standard sand recommended by the American Society. At all events, we decided to use it for the important job above referred to. The center pier in question was built from it, and the pier stands to-day as an excellent piece of concrete work which has plenty of life and ring.

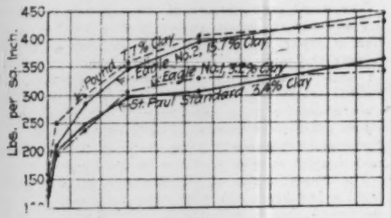


Fig. 1. Tensile Tests of 1 to 3 Mortar, with Pit Sand Containing Clay. (See Group II. in Table.)

My opinion of this soft fine sand has improved. The laboratory tests were much better than I expected. The character of the concrete made from it appeared to be all that could be desired. An excessive haul was saved by using it. On the other hand, I am not in favor of using a sand of this character without first making laboratory tests. All soft fine sands do not act alike.

Another sand in this same glacial district which was still more of a surprise than the above, was the Pound sand, tests of which are platted and tabulated. Its noticeable peculiarity was the presence of foreign material which resembled clay. The damp sand, when taken from the face of the bank, was plastic, and readily caked in the hand like putty. The particles of silica were held together by the clay. A coating of fine material clung to the hand after handling it. To one accustomed to the usual specifications for a clean sand, free from foreign substances, this would fall far short of being satisfactory. Laboratory tests were made, extending to three years. These tests, to our surprise, showed it to be superior in every respect to our standard sand. The 7-day and 28-day tests of this were respectively 40% and 30% above the standard. The difference became less with age, although the three-year test was 20% above the standard. This surely was contrary to the then general impression of a good sand, especially at the time these tests were started. The sand was found to contain 7.7% of fine material by decantation; that is, material held in suspension, all of which was perhaps clay. There appeared to be no other peculiarity, and hence it was thought that this clay was beneficial to the sand. At all events, the sand tested so well that it was considered perfectly safe to use it for ordinary concrete purposes. The question of using it under water, where clay might retard setting, was not gone into.

I wish next to call your attention to Eagle No. 1 and No. 2 sands, shown in the diagram and tabulation. The former contained 3.2% of material held in suspension, while the latter contained 15.7%. Eagle No. 1 was selected for the best sand in the pit, and No. 2 for the poorest. Both sands seemed questionable. Before tests were made, we even doubted the advisability of using any sand from this pit, but decided to order out a shipment of the best (No. 1) for an unimportant job, and follow with tests. The tests proved the unexpected. To our surprise, both tested well, and what was a still greater surprise, the No. 1 Eagle, which contained 3.2% of clay showed up poorer than the No. 2 which contained 15.7%. The particular sample of St. Paul standard sand with which they were compared contained 3.4% of material held in suspension, largely clay. The strength of all three sands, while irregular, appeared to be governed largely by the amount of material held in suspension, or in other words, the amount of clay. We surely were mistaken in our first estimate of these sands.

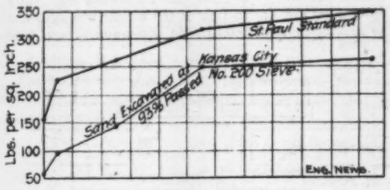


Fig. 4. Tensile Tests of 1 to 3 Mortar with Extremely Fine Sand. (See Group V. in Table.)

Still another test, which proved the superiority of clay in sand in a different way, was the Jackson (Minnesota) pit sand, one sample of which was washed, and one not. The unwashed showed up about 25% superior, although it contained 6% of clay. On the other hand, the washed sand averaged considerably below our standard, about 30%, and the unwashed a trifle below, though very close to it. This comparison to the standard sand is contrary to what we found in the previous sands from the Eagle pit, because the unwashed Jackson sand, which contained 6% of clay, did not test better than the standard sand which contained only 1%. By looking further, however, and comparing the fineness of the Jackson and standard sand, as per tabulation, it will be seen that the standard is a much more desirable mixture of fine and coarse particles, which the writer believes accounts for the discrepancy, and which will be touched upon later. This is another example where the presence of clay improved the sand.

The above tests of sands containing clay in their natural state, as well as many others which I have not taken time to mention, tend to prove that the presence of small percentages of clay is not objectionable, but on the other hand, may be desirable. This, however, does not prove that sand containing ordinary soil is better than one without it. To decide this, we made a series of tests of washed sand to which was artificially added 2%, 5%, 10% and 20% of rich surface soil consisting principally of decayed organic matter. The soil was taken from the bank of the Chicago River where undisturbed weeds had thrived and decomposed season after season, and made the richest kind of soil. The results were disappointing. They were neither decidedly inferior nor superior, but proved quite irregular. The tests up to two years showed that at some period they were above the sand containing no soil, while at others, they were below. The percentage of soil added did not cause the tests to follow any definite law. The 20% adulteration had comparatively little different effect than the 2%. As a whole, the average strength of the tests up to two years, was about the same as the clean test, but the irregularity was so great as to make the artificial sands less desirable than the natural. The diagram will make this clear. It would seem from this that sands with a small admixture of soil ought not to be condemned without first making tests, but, on the other hand, it is not as desirable as one without soil. Sands of this character (containing soil which consists of decomposed vegetable matter) are rarely found in nature. The soil simply overlays the sand pits, and can be easily stripped off. A rare case of river deposit might occur which contained soil, though this is contrary to expectation because of the difference in specific gravity of the sand and soil. The two are seldom deposited together. The natural sands are generally found mixed with clay, which consists of decomposed rock.

Let me refer you to an article published in Engineering News of Nov. 19, 1903, by Professor C. E. Sherman, of the Ohio State University, in which he reports laboratory tests up to one year, of Portland cement, with different sands mixed with 0, 2, 4, 6, 8, 10 and 15% (by weight) of clay and also loam. With very few exceptions, the adulterated sand tested superior to the natural sand. In most cases the 10 and 15% mixtures tested quite uniformly and proved superior by roughly 25%. With one exception the clay showed up slightly better than the loam mixtures.

His artificial clay-sand tests proved the same as our observations of natural sands containing clay. His artificial loam-sand tested superior to our artificial soil-sand. This latter difference is perhaps due to the difference in character of the material added. He describes the loam as "A common field soil obtained from the field north of the power house on the State University campus." Quite probably, in place of all decomposed material, it contained some clay, and possibly also some sand. This is the only way I can account for the superior comparative showing of the loam tests he made over our comparative soil tests. A small quantity of clay in the loam would change the results.

I will add here, that there are two ways in which foreign material occurs in sand banks, one in the form of a fine material, uniformly distributed throughout it, and another in the form of layers or pockets which are entirely distinct from the sand. The cases mentioned, both natural and artificial, were the former. A specification which permits a definite amount of foreign material, must however, exclude all sand in which such material is not uniformly distributed throughout the sand, or in other words, a part of it.

There are still other peculiar sands to be met with in nature. Your attention is especially called to one other natural sand which seemed to me most striking. It was excavated in Kansas City, on the location of a freight house foundation, which, in the flood of 1903, was several feet under water. From appearance and action it was hard to determine whether it contained a larger percentage of sand or clay. What grains it contained were so fine that they were scarcely perceptible to the touch. The quantity of clay seemed large because the trenches stood perfectly vertical under ordinary conditions. From the grit, I concluded it was sand, with a rather large percentage of clay. Tests were made of it and up to date we have the one year results. It proved to be a very fine sand which contained about 12% of material in suspension, largely clay. The most striking peculiarity was its fineness. Everything passed through a No. 100 sieve, and 93% passed a No. 200. In fineness it was far superior to cement. I know of only one cement which is guaranteed 85% in fineness on a No. 200 sieve. The usual specifications require about 75%. Under an ordinary lens, the grains of this sand were not visible. They appeared to be mostly smooth grains of silica.

The tests proved as interesting as the fineness. The early ones were low. The seven and 28-days averaged about 35% of the standard. The three months showed a good gain, while the six months and one year averaged about 77% of the St. Paul standard, which is about the same showing made by the Ottawa sand recommended as a standard by the American Society of Civil Engineers. The 12% of foreign material, presumably clay, quite likely helped to improve the tests. I consider that this fine sand shows up remarkably well, in view of the fact that it is finer than the finest cement, and that 93% passed a No. 200 sieve. It quite likely could be used in massive masonry, were it possible to allow the concrete to set for a year before subjecting it to severe strains.

I might call your attention to many other sands from along our line which have been tested in our laboratory. The foregoing, however, illustrate the peculiarities most strikingly. Before concluding, I wish to say a little

TESTS OF VARIOUS SANDS FOR MASONRY WORK ON THE CHICAGO, MILWAUKEE & ST. PAUL RY.
(The sands were mixed with Portland cement in proportions of 1 to 3 and briquettes made from the mixture were tested for tensile strength.)

| Sand. | | | 7 Days. | | 28 Days. | | 3 Months. | | 6 Months. | | 1 Year. | | 2 Years. | | 3 Years. | | Average % of Standard. | % by weight of Sand passing through & held between the | | |

more in regard to the effect of washing, and also the effect of fineness on sands in general.

It will be remembered that the washed Jackson sand tested inferior to the unwashed which contained 6% of clay. The washing was done according to the laboratory practice (decantation). Immersed sand was shaken up in a water bottle and allowed to settle. The portion held in suspension was poured off. This process was continued until nothing was held in suspension. It will be seen that this method of washing differs widely from the regular practice used at the sand pits. It is my opinion that the Jackson sand would not have tested as well had it been subjected to regular washing in place of the laboratory method. The finer particles of sand would have been carried off with the clay. This would have left larger voids in the sand, and consequently it would not have tested as satisfactorily. Therefore, I believe that washing, on general principles, is not desirable unless conditions are unusual. At all events, the sand should be tested, washed and unwashed before going to the expense of fitting up a plant for washing. Unless the sand naturally contains an excess of fine particles, or of foreign substances, I doubt if washing will better it.

Next in regard to the distribution of fine and coarse particles, a study of the table of fineness will show that the strength of a sand depends to a considerable extent on the proper distribution of the fine and coarse particles. The Ottawa sand, which was favorably recommended by the American Society of Civil Engineers, does not test well because its fineness is limited between a No. 20 and a graded. A coarse sand may show up poorly if there are too few fine particles to fill the voids. The best graded sand is one in which the grains held on a uniform series of sieves is so arranged that the voids in one lot are filled, and not overfilled, by the grains in the next smaller size, and so on. This grading should begin with large grains in order to limit the surfaces exposed to cement, and still these grains must not be so large that the voids will not be filled with the smaller particles.

Briefly, then, the best mortar sand found in nature is one with sharp corners, rough surfaces, with grains neither coarse, medium nor fine, but with the proper mixture of all these sized particles which will result in the least voids. The sand also, should not be washed, but may contain up to 12% of clay, which will not injure, but will perhaps improve it.

ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Canadian Society of Civil Engineers was held at the society headquarters, 877 Dorchester street, Montreal, from January 24 to 26, 1905. The meeting was well attended, and this index of the flourishing condition of the society was confirmed by the reports of the Council and the Treasurer. The former reported a membership of 1,253, which is an increase of 108 over the total for the previous year. The Treasurer's report for the year showed while there was a deficiency in receipts over 1903, of $1,126, yet the expenditures were about $1,000 less than the receipts from fees ($5,737 and $6,770, respectively). The statement of assets and liabilities showed a surplus of assets of $28,387.56. The Library Committee reported a considerable increase in the society's reference library and the near completion of a proposed collection of trade catalogues. The publications of over 400 engineering firms, amounting to a total of about 1,800 books and pamphlets have been secured and the work of their classification and indexing by subjects and firms is now in progress.

The report of the Council also states that the Gzowski Medal for the year 1903-4 has been awarded to Mr. J. A. Jamieson for his paper upon "The Pressure of Grain in Deep Bins, and the Problem of Grain Bin Design," which was reprinted in Engineering News of March 10, 1904.

In his address to the society the retiring president, Col. W. P. Anderson made reference to the visit in September, 1904, of the President and a representation of the Members of the Institution of Civil Engineers as one of the most notable events in the annals of the society, and to the strong impression made on those gentlemen by the magnitude of the various engineering works inspected. He referred to the plentiful presence in Canada of the constituents of Portland cement, to the valuable water powers available for industrial development, to the opening up of the Canadian Northwest through the building of the Grand Trunk Transcontinental line, to the advocacy of the establishment of a central bureau for the registration of plans of all surveys made in Canada, and to the question of better surveys of the Dominion. A valuable and interesting feature of Col. Anderson's address is the information, relative to the engineering work under the charge of the Dominion Department of Marine and Fisheries, with which he has been connected. This department, first organized after confederation, was placed in charge of all aids to navigation, which had previously been administered by the several Colonial Governments, and by a few semi-independent boards. We quote the following paragraphs:

At the time of confederation there were throughout Canada 227 lighthouses at 198 stations, and only two of these were equipped with steam fog whistles. Since 1867 there have been established in the Dominion, 769 new lighthouses at 598 different stations, 71 power fog alarms, 15 fog bells, 10 explosive fog signals, 89 signal buoys, and 106 gas lighted buoys, numbers far exceeding the total establishment of any country in the world except the United States of America, and very little inferior to the aggregate in that country of great wealth and magnificent distances. A majority of these appliances were designed and put in operation under the superintendence of myself, who for a long time, happily now past, enjoyed the distinction of being the only lighthouse engineer in Canada. Of late years our attention has been turned to improving aids rather than to rapidly increasing their numbers. In lighthouse illumination catadioptric lenses are rapidly being substituted for the older fashioned, simpler, and less expensive paraboloidal reflectors, and petroleum vapor burnt under incandescent mantles is taking the place of the ordinary oil light. These petroleum vapor lights are very efficient and economical. Photometric tests show that ten times as much light can be got from the vapor burnt under mantles as from the same oil burnt through wicks. The possibility of increasing the power of our Canadian lights is unfortunately limited by the capacity of our lightkeepers. As long as these officials are put in charge of stations without any previous instruction in their duties, so long will it be necessary to limit the size of the lamps to such as can be managed by ordinarily intelligent men. To place lamps with large, intensely hot flames in the hands of uninstructed keepers is to invite destruction of the buildings and apparatus. Until the appointment of lightkeepers can be restricted to young men nominated to go through a course of preliminary training under competent instructors, with the power of instant dismissal for breaches of duty in the hands of the Inspectors, it will be impossible to much further improve our lighthouse installations.

Most of our gas buoys and some of our small fixed lights are now using acetylene in compressed form as an illuminant, but there are difficulties, not the least of these being its cost, that will militate against its general adoption, especially in the face of a rival so formidable as petroleum vapor.

Electricity has never been used to any great extent in our lighthouses for many reasons, one being the liability of the machinery to break down, another the untrained lightkeepers we are obliged to employ. In the vicinity of towns having municipal or private electric plants, electric lights have in a few instances been installed, and operated by the municipal power station. An important advantage of electricity, where it is available, is the facility with which occultations can be produced.

In exposed positions on the sea coasts whistling buoys on the Courtenay principle, another clever invention, and the old-fashioned bell buoys, are used more extensively than gas buoys, being better adapted to stand the shock of the waves, and requiring no special attention beyond periodical lifting to remove sea growths and renew the moorings. The work of placing and renewing the 89 signal buoys now in commission, and the thousands of smaller buoys, studding all our harbors and rivers, employs quite a fleet of steam tenders.

The first Canadian fog alarms were steam whistles. About 1873 reed horns were substituted, from motives of economy, a very simple and fairly effective arrangement, patented in Canada, being adopted. In these machines the lifting of a piston in a steam cylinder compressed air in a larger cylinder immediately above, and forced it through the horn, so that the length of blast was regulated by the stroke of the steam piston. One of these horns has been heard 26 miles under favorable conditions. They were not, however, considered first-rate fog alarms, and when larger grants became available, syrens of the Scotch and English types were adopted as the most powerful sound producers obtainable. A first-class English syren at Belleisle is operated by air compressed half a mile from the syren house, the power being obtained from a Pelton wheel run by water led from the lakes on the

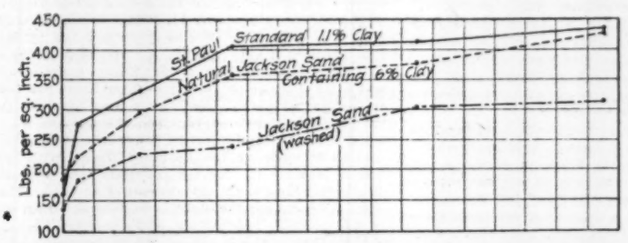


FIG. 2. TENSILE TESTS OF 1 TO 3 MORTAR WITH JACKSON SAND, WASHED AND UNWASHED.
(See Group III. in Table.)

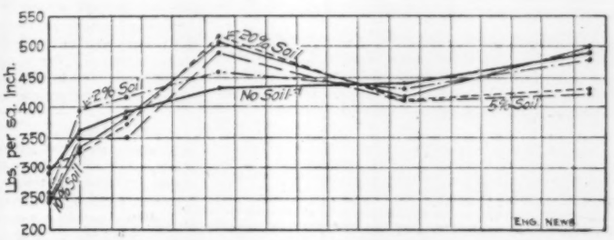


FIG. 3. TENSILE TESTS OF 1 TO 3 MORTAR WITH "ST. PAUL STANDARD SAND" MIXED WITH SOIL.
(See Group IV. in Table.)

No. 30 sieve. It is natural to expect that the absence of small grains leaves larger unfilled voids, and consequently the tests are not as strong. Tests of this sand only averaged about 80% of the St. Paul standard. I attribute the good showing of our standard largely to the better distribution of the different sized particles.

It is difficult to decide what distribution of grains would be most suitable. Please note, however, that the meshes of one sieve are about one-quarter the size of the next larger sieve, and that if there are 40% of voids in the sand held between two sieves, there ought to be about the same amount of sand held between the next smaller sized sieves, or enough to fill these voids, etc. On this assumption I have figured out and tabulated the fineness of a sand that ought to give the best results. A sand might vary from this considerably and yet not alter results materially because some other distribution of particles might result in as few voids, with only a slight increase in the surfaces to be coated with cement.

By comparing the excavated Kansas City sand with the fine "Track Elevation" sand, both of which are shown in the tabulation, it will be seen that the finer of the two, though it is much finer and hence has considerably more surface, tested better. This, I think, is partially accounted for by the undesirable distribution of the particles in the "Track Elevation" sand; 83% of the latter sand is held between a No. 50 and a No. 100 sieve and the percentage of fine particles below this is not enough to fill the voids (see table). However, as stated in the earlier part of this paper, the fine flour-like sand has the advantage of 12% clay, but this alone, in my judgment, does not account for the difference in showing. I also attribute the low tests of the Rockton sand shown in the tabulation to the same cause. There are not enough fine grains below the No. 50 sieve to fill the voids of larger particles. We have made a great many other tests which tend to prove that this supposition is correct, but which I will not take time to go into.

To sum up the situation it is quite evident that clay in limited quantities (say not to exceed 12%) is beneficial if thoroughly distributed throughout the sand. Before using, however, it ought to be compared with an established standard.

Soil, on the other hand, is detrimental. Sand containing it shows up irregularly. Such sand should be proven satisfactory by tests before using.

Washed sand may be less desirable than unwashed. Washing removes the fine particles as well as the foreign material. The fine grains, if not in excess, are needed to fill the voids of the larger. The only safe way to decide whether sand ought to be washed, would be to test it under both conditions.

A fine sand may show up well if the grains are well

hills of the island. This installation has run successfully for many years, the cost of maintenance being a mere trifle.

The Government is now substituting diaphones for all the types of instruments previously used for fog alarms. These instruments are claimed to give a very penetrating sound. They have the advantage over the syren that they can be kept at a constant pitch, and if the Canadian patentees succeed in producing perfect resonation they will doubtless prove superior in sound-carrying capacity to any signal yet invented. They are run by compressed air, and we are installing oil engines to operate them, because it is frequently difficult to obtain sufficient fresh water for steam engines at our fog alarm stations. The sound is produced by the free vibration in a slotted cylinder of a very light slotted piston, the air being admitted in rear of the piston, and escaping through the slots, which are alternately opened and closed sufficiently fast to produce a pure musical note.

On January 25 the members visited the works of the Dominion Bridge Company, where lunch was served; of the Dominion Wire Manufacturing Co.; of the Dominion Wire Rope Works; and the Works of the Allis-Chalmers-Bullock Company. For this trip a special train had been placed at the service of the society by the courtesy of the Grand Trunk Ry.

In the evening the Annual Dinner was held in the Windsor Hotel, when a number of interesting short speeches were made.

Among those who responded to toasts were Hon. F. B. Walle, Chairman of the Transcontinental Railway Commission. We quote the following extracts from his remarks, as reported in the "Montreal Gazette":

A great work had been undertaken in constructing a new transcontinental railway, with a commercial grade. When commencing this work, it had been determined to accomplish it, if possible, with the aid of Canadian engineers alone. Whether this would be realized or not remained to be seen, but one thing was certain, the determination to exhaust the home supply before seeking for others abroad. He considered that the Canadian engineers were better adapted to the conditions and circumstances in hand than engineers imported from abroad, for the simple reason that the latter had to learn the conditions, which were already known to the engineers here. There were at present in the field nearly forty parties, all officered by Canadian engineers, who had given the most unqualified satisfaction, not only to their chiefs, but to the commission. He trusted that they would be able to say, at the end of their work: "We have accomplished this work and constructed the road we were called upon to construct, and we have done it by the aid of Canadian engineers alone." If that was accomplished, it would be a matter of great credit to the profession.

The meetings for the reading of technical papers were held Thursday, Jan. 26, in the afternoon and evening. The following papers were read: "The Effect of Load Factor on the Cost of Electric Power," by Mr. E. M. Archibald; "The Construction of the Canadian Niagara Power Company's Plant at Niagara Falls, Ont.," by Mr. Cecil B. Smith, Resident Engineer in Charge of Construction; "Maps and Map Making in Canada," by Mr. James White, Geographer for the Dominion Government; "The Electro-Thermic Production of Iron and Steel," illustrated by a small Heroult steel furnace in operation, by Dr. E. Haanel, Dominion Superintendent of Mines. We hope to present abstracts of some of these papers in a future issue.

The election of officers for the year 1905 resulted as follows: President, Mr. E. Marceau, Superintending Engineer, Quebec Canals, Montreal; Vice-Presidents, Messrs. C. H. Keefer, Ottawa, D. McPherson, Montreal, and G. A. Mountain, Chief Engineer of the Grand Trunk Railway Commission; Treasurer, Mr. H. Irwin, Montreal (reelected); Secretary, Prof. C. H. MacLeod, McGill University, Montreal (reelected); Librarian, Mr. H. R. Lordly, Montreal. A biographical sketch of President Marceau, accompanied by a portrait, appeared in last week's issue of Engineering News.

THE ABOLITION OF THE PANAMA CANAL COMMISSION is provided for by a bill introduced by Representative Mann, of Illinois. The bill was favorably reported by the House Committee on Commerce, on Jan. 31. It vests in the President sole authority over the Canal work.

BIDS FOR A SLOW SAND FILTRATION PLANT and accessories for the city of Pittsburg, Pa., are to be received until March 8, as stated in detail in our "Proposal" columns. The work includes, among other things, 46 covered filters of one acre area each, a covered clear water reservoir with an area of 6.3 acres, 48 to 124-in. reinforced concrete conduits, a low and a high duty pumping station with pumping plants complete and three reservoirs. The work is divided into ten separate contracts, requiring an aggregate of $3,000,000 of bonds. Mr. Wm. B. Hays is Mayor; Edward M. Bigelow, M. Am. Soc. C. E., is Director of the Department of Public Works, and Mr. Morris Knowles, M. Am. Soc. C. E., is Chief Engineer of the Bureau of Filtration.

PROGRESS ON THE SIMPLON TUNNEL in December, 1904, was as follows: The north heading, in which no advance work has been done for some months, remained in this status. The south heading, where advance work has been held up by water since August, 1904, was brought into shape for advance about the middle of December. During the previous months the parallel tunnel had been pushed forward, to a point beyond the main heading, and a cross drift was carried to the axis of the main tunnel. This tapped the water flowing to the main heading and enabled work here to be resumed. Machine drilling at the new face of the main tunnel was at once taken up, and by the end of December the heading had been advanced to 9,185 m. total length, leaving only 169 m. (554 ft.) between north and south headings. In addition, the distance of 23 m. between the abandoned face and the new face at the cross drift remains to be penetrated. The headings may be expected to meet within a few weeks.

A GAS EXPLOSION AT GARNETT, KAN., on Jan. 16, resulted in the death of two men, one instantly and the other in a few hours, the injury of three persons and property damage estimated at $35,000. The explosion occurred, it is supposed, in the cellar of a bakery, destroying the bakery and two other buildings and injuring several other buildings. The explosion has been attributed to natural gas, which was introduced in Garnett about the middle of December, and also to so-called "sewer gas."

TRACK ELEVATION WORK IN CHICAGO during 1904 was largely of a preliminary character, including the construction of retaining walls, the filling in of which and actual elevation of tracks being left to another season. Two important ordinances were introduced last November: 1, The elevation of tracks of a number of railways in the district bounded by Stony Island Ave., the Indiana state line, 79th St. and 101st St.; this comprises 15.13 miles of main track, 36.38 miles of all track, and 63 subways, and is estimated to cost $3,710,000. 2, The elevation of the Chicago & Northwestern Ry. and Chicago & Oak Park Elevated Ry. (which is the old Lake St. elevated road, extended into the suburbs as a surface line parallel with and adjacent to the C. & N. W. Ry.), from N. 46th Ave. to Austin Ave.; 2.53 miles of main track, 4.06 miles of all tracks, 22 subways; estimated cost, $900,000. The status of the work, according to the report of the Track Elevation Commission for 1904 (John O'Neill, Superintendent of Track Elevation) may be tabulated as follows:

	Ordinances passed and accepted. May 23, 1892, to Dec. 31, 1904. Work planned.	Work done.	Work to be done.
Miles of main tracks.	138.10	82.84	55.26
Miles of all tracks...	709.95	425.19	284.76
No. of subways	537	360	177
Estimated cost	$44,200,250	$29,725,250	$14,475,000

If the two new ordinances above-mentioned are passed by the Council and accepted by the railways, they will increase the total estimated cost to $48,810,250 with $19,085,000 yet to be expended.

Statistics collected by the Health Commissioner show that the track elevation work thus far done has greatly reduced the casualties at grade crossings. In 1893 more than one-third (36%) of the deaths by violence in the city were caused by railroad accidents within the city limits. In the past five years the proportion of the violent deaths ascribed to railroad casualties has fallen to an average of less than 15%.

GRADE CROSSINGS in the State of New York are reported upon by the New York State Railroad Commission. There are 540 crossings of one steam railroad by another of which 280 are either over or under grade and 260 are at grade. All but 13 of these grade crossings are protected. There are 10,384 crossings of steam railways and highways or streets. Of this total, 6,883 are unprotected, 1,970 are protected in some way, and 1,531 are over or under grade. There are in the state 445 crossings of steam railway tracks by street railways (almost all the street railways are of course operated by electricity). Of these 192 are over or under grade, 191 are protected in some way and 62 are unprotected. The very considerable number of over and under crossings shown in the above figures are largely the result of work done in the removal of grade crossings during the years from 1898 to 1902, no less than 142 grade crossings having been removed during that time.

THE COMPRESSED AIR PLANTS for the Pennsylvania tunnel work under the Hudson and East Rivers are being installed. The main compressing plants for the East River tunnel will include 12 Ingersoll-Sergeant cross-compound Corliss compressors with duplex air ends. Of these eight are low pressure units, each with a capacity of 5,000 cu. ft. of free air per min. compressed to 50 lbs. The air from these machines will be used for keeping out the water in driving the shields. Two of the high pressure units will each have a capacity of 1,500 cu. ft. of free air raised to 100 lbs., to be used for driving concrete mixers, rock drills, and possibly for haulage. The remaining two units will serve the purpose of reserve units for either the high or the low pressure compressors. These 12 units will be divided equally between the two stations, on opposite sides of the East River; and each station will be served by a battery of five 500-HP. water-tube boilers delivering steam at 150 lbs. It will be remembered that the East River tunnel contract involves the driving of four tubes, each 33 ft. in diameter, and that S. Pearson & Son, Inc., have the contract.

The Hudson River work involves the driving of only two tubes and a smaller plant is needed. A total of eight Ingersoll-Sergeant compressors are to be used, four on each side of the river. Six are low pressure (50-lb.) units, each having a capacity of 4,000 cu. ft. of free air per min.; two are high pressure (100-lb.) units, each having 920 cu. ft. of free air per min. Three 400-HP. water-tube boilers on each side of the river will furnish steam at 150 lbs. The O'Rourke Engineering Construction Co., of New York, has the Hudson River tunnel contract.

These four power plants represent in the aggregate, it is claimed, the largest installation of air compressing machinery ever made for general power purposes.

GARBAGE DISPOSAL BY FEEDING TO HOGS and by burying what the hogs do not eat has been practiced at St. Louis, Mo., since Nov. 14, 1904. This method of disposal was adopted as an emergency measure by Mr. Hiram Phillips, M. Am. Soc. C. E., President of the Board of Public Improvements of St. Louis, under conditions which Mr. Phillips has kindly outlined to us substantially as follows: Somewhat less than a year ago, for reasons having no bearing whatever upon the way the work was being done, the State Supreme Court held void the contract previously made by the Board of Health with the Excelsior Hauling Co. for the collection, and with the St. Louis Sanitary Co. for the disposal of garbage. The city, soon after, bought the stables, wagons and draft animals of the Excelsior Hauling Co., and since then has collected the garbage. The Board of Public Improvements continued the contract for disposal until the natural date of its expiration, on Nov. 14, 1904. The Municipal Assembly having failed to authorize the Board of Public Improvements to make permanent arrangements for garbage disposal, it devolved upon the President of the Board to make some temporary arrangement. Accordingly, since Nov. 14, the garbage has been barged twenty miles down the Mississippi River to Chesley Island, near the Missouri shore. There are now about 1,000 hogs on the island. What of the garbage they do not eat is spread over the ground in a 4-in. layer and ploughed in. The garbage is not weighed, but Mr. Phillips estimates the average daily quantity as 130 tons. He also estimates that the island will not receive a coating over its entire area in less than a year. The St. Louis Sanitary Co. was paid $130,000 a year for the disposal of garbage and dead animals, or about $359 per day. Garbage disposal alone now costs the city less than $140 a day. The dead animals are now treated free of charge, under an emergency contract, by the Mayer Fertilizer & Junk Co. The animals are delivered by the city to the company's works, which are located in the extreme northern part of the city. The city has entered upon an experimental test of the Dixon garbage furnace, located on the World's Fair grounds. About 25 tons of garbage are being burned daily, and careful records of the cost of labor and fuel are being kept. It is proposed to continue the test for 90 days.

AN INGENIOUS METHOD OF LUBRICATING gas engine cylinders is described by the Prouty-Pierce Locomotive Mfg. Co., of Kansas City, in a letter published in the January issue of "Graphite," the journal issued by the Joseph Dixon Crucible Co., of Jersey City. We quote from the letter as follows:

We have made it a practice for some time to make the last but on the piston with a diamond-pointed tool with slow feed enough to give it very fine lines on the surface, or what might be called slight corrugation. We frequently give the cylinder the same treatment in the last cut, but cannot always do this so conveniently on account of using large tools with large feed; but we never fail to do it on the piston. The object of this treatment of the piston is to load this slightly broken surface with graphite, and the result is that it faces up evenly and we have the two materials—the cast iron and the graphite—coming in contact with the surface of the cylinder. You will note that when the graphite is once crushed into this uneven surface and evens it up, it remains there perpetually; but, of course, graphite should be used all the time to keep the body intact.

As a result of this treatment, our engines will run for years without having to be re-bored. Nearly all gasoline engine builders have fallen into the erroneous habit of polishing the piston, so that the graphite cannot lodge and retain as strong a hold on the iron to make permanent surface. In addition to this slightly corrugated surface, we cut a groove in the form of rings around the piston which is always loaded with graphite and oil to reinforce the lubrication of the entire working surface.

A GASOLINE LOCOMOTIVE weighing only three tons, for light narrow-gage tracks, has been built by the Wolseley Tool & Motor Car Co., of Birmingham, England. It

is fitted with two 6 x 7-in. cylinders which are connected through Renold silent chains and speed reducing gearing to the coupled driving wheels. Two speeds are provided of 3 miles and 8 miles per hour. The machine can haul a load of 15 tons on a level track and when fully loaded is said to use about two gallons of gasoline per hour.

THREE TRANS-PYRENEES RAILWAYS to connect the railway systems of France and Spain have been decided upon by a convention of representatives of the two countries, and are to be built within ten years. The lines run approximately north and south; the eastern line is from Aix-les-Thermes, in France, to Ripoll, in Spain; the second is from St. Girons to Sort and Lerida; the third is from Oleron to Canfranc and Jaca. The lines will be from 65 to 160 miles in length, and will involve heavy construction works, including long tunnels through the mountain range which separates the two countries. At present there are railway connections only at Irun on the Atlantic coast and at Port Bou on the Mediterranean coast. It is to be noted, however, that while the French railways have a gage of 4 ft. 8½ ins., the Spanish railways have a gage of 5 ft. 6 ins., which cuts them off from interchange of traffic with the rest of Europe.

ENGINEERING MATERIAL PRICES.

(These prices will appear in the first or second issue of each month.)

TRACK FASTENINGS—
Chicago—at mill—Angle bars, 1.35 to 1.40 cts.; spikes, 1.70 to 1.75 cts.; track bolts, 2.30 to 2.45 cts.

RAILS, STEEL—
New York—at mill—New standard sections, $28; light rails, $23 to $24.50; old iron, f. o. b. New York, $21.50 to $22.50; old steel, rerolling lengths, $16 to $17; old steel, short pieces, $15.50 to $16.50; relayers, $20 to $21.
Chicago—at mills—New, $28, standard sections; light rails, $24 to $30; old iron, $21 to $21.50; old steel, 4 ft. and over, $16 to $16.50; old steel, less than 4 ft., $16 to $16.25; heavy relayers, $22.50 to $23; heavy relayers for side tracks, $20 to $20.50.
Pittsburg—at mill—Standard sections, $28.

STRUCTURAL MATERIALS—
New York—at tidewater—Beams, channels, angles and zees, 1.64½ to 1.80 cts.; tees, 1.69½ to 1.80 cts.; bulb, angles and deck beams, 1.74½ to 1.85 cts.
Chicago—I-Beams and channels, 3 to 15-in., inclusive, and angles 3 to 6-in., ¼-in. and heavier, 1.66½ cts.; tees, 3-in. and over, 1.71½ cts. Store prices, angles, beams and channels, 1.90 cts.
Pittsburg—Beams and channels, up to 15-in., 1.50 cts.; over 15-in., 1.60 cts.; angles, 3 x 2 x ¼-in. thick up to 6 x 6-in., 1.50 cts.; angles, 8 x 8 and 7 x 3½ ins., 1.60 cts.; zees, 3-in. and larger, 1.50 cts.; tees, 3-in. and larger, 1.55 cts.

PLATES AND SHEETS—
New York—at tidewater—Sheared plates, carload lots, tank, 1.64½ to 1.75 cts.; flange, 1.74½ to 1.90 cts.; marine, 1.84½ to 2 cts.; fire box, 1.84½ to 2.50 cts.
Pittsburg—Tank, ¼-in. thick 6¼ to 14-in. wide, 1.40 cts. at mill, Pittsburg; flange and boiler steel, 1.50 cts.; marine and ordinary fire box, 1.60 cts., at mill, Pittsburg; locomotive fire box, 1.90 cts.

MERCHANT STEEL—
Chicago—Machinery, smooth finished, 1.81½ cts.; tire, smooth finished, 1.76½ cts.; railway spring, 1.76½ cts.; crucible tool, 6½ to 8 cts.; special tool, 13 cts. and up.
Pittsburg—Open hearth spring steel, 2 to 2.10 cts.; tire steel, 1.60 to 1.65 cts.; smooth finished machinery steel, 1.60 cts.; toe calk steel, 1.90 to 2 cts.

IRON—
Pig Iron:
New York—No. 1 X Foundry, $17.75 to $18; No. 2 X Foundry, $17.25 to $17.50; No. 2 Plain, $16.75 to $17; Gray Forge, Northern, $15.75 to $16; Southern No. 1 Foundry, $17.75 to $18.
Chicago—f. o. b., Chicago.—Lake Superior charcoal, $18.50 to $19; Northern Coke Foundry, No. 1, $18; Northern Coke Foundry, No. 2, $17.50; Northern Coke Foundry, No. 3, $17; Northern Scotch, No. 1, $18 to $18.50; Ohio Strong Softeners, No. 1, $19.30 to $19.80; Ohio Strong Softeners, No. 2, $18.80 to $19.30; Southern Silvery, 4 to 6% Silicon, $18.65 to $19.65; Southern Coke, No. 1, $17.65 to $17.90; Southern Coke, No. 2, $17.15 to $17.40; Southern Coke, No. 3, $16.65 to $16.90; Southern Coke No. 4, $16.40 to $16.65; Southern Coke, No. 1, Soft, $17.65 to $17.90; Southern Coke, No. 2, Soft, $17.15 to $17.40; Southern Gray Forge, $16.50 to $16.75; Southern Mottled and White, $15.90 to $16.15; Malleable Bessemer, $17.50; Standard Bessemer, $18.50 to $19; Jackson County and Kentucky Silvery, 6 to 8% Silicon, $20.30 to $22.30; Jackson County and Kentucky Silvery, 10% Silicon, $23.30; Alabama Basic, $17.15 to $17.40; Virginia Basic, $17.15 to $17.40.
Pittsburg—Bessemer at Valley furnace, $15.75 to $16; Foundry iron, Northern No. 2, $16 to $16.50; at furnace; Northern forge, $15.25 to $15.40 at Valley furnace.
Cast-Iron Pipe:
New York—Carload lots, net tons, 6 to 10 ins., at tidewater, $26.50 to $27.
Chicago—4-in. water pipe, $28.50; 6-in. and heavier, $27.50 with $1 extra for gas pipe.

MISCELLANEOUS MATERIALS—
Asphaltum:
Ventura and other California asphalts, $20 to $21 per ton at New York; Trinidad refined, $25 to $30 per ton; Venezuela asphalt, $25 to $30 per ton.
Cement:
Rosendale, in wood, $1; Portland, domestic, $1.70 to $1.80; Foreign brands, $2.25 to $2.50.
Copper:
Lake, 15.25 to 15.37½ cts.; electrolytic, 15½ to 15.25 cts.; casting, 14.87½ to 15 cts.
Lead:
New York, spot, 4.45 to 4.55 cts.
Spelter:
New York, spot, 6.20 to 6.30 cts.
Tin:
New York, spot, 29.80 to 29.92½ cts.

LUMBER—
New York, wholesale prices:
Piling—Spruce, ordinary cargoes, 5 to 6 cts.; oak, 14-in. butt, 40 to 50 ft., 19 cts.; 50 to 55 ft., 22 cts.; 55 to 60 ft., 23 cts.; 60 ft. and up, 25 cts.; pine, 60 to 65 ft., $8.50; 65 to 70 ft., $9.50; 70 to 75 ft., $10.50; 50 ft. and up, $16.
Railroad ties—Yellow pine, 6 x 9 ins. x 8 ft., 58 to 60 cts.; 6 x 8 ins. x 8 ft., 53 to 55 cts.; 7 x 9 ins. x 8 ft., 62 to 64 cts.; 7 x 8 ins. x 8½ ft., 57 to 59 cts.; 7 x 9 ins. x 8½ft ., 64 to 66 cts.

PERSONAL.

Mr. Arthur L. Southworth, a civil engineer, located at Stoughton, Mass., and Miss Mabel S. Jones were married Jan. 19 at Stoughton.

Mr. Harry E. Blake has been appointed City Engineer of North Adams, Mass. Mr. Blake is a graduate of Cornell University in the Class of 1873.

Mr. Michael F. Buckley, Superintendent of the waterworks system of Penn Yan, N. Y., has accepted the Superintendency of the Penn Yan Gas Co.

Mr. George W. Snow has resigned as City Engineer of Salt Lake City, Utah, and Mr. George W. Riter has been appointed to that position to succeed him.

Mr. George H. Bliven, of Greenville, N. C., has been appointed Superintendent of the plant of the Rochester & Lake Ontario Water Co., of Rochester, N. Y.

Mr. C. S. Herrick, of 909 Harrison St., Syracuse, N. Y., has accepted a position with the Archbold-Brady Co., of Syracuse, N. Y., Engineers and Contractors of structural iron and steel.

Mr. F. H. Johnson, for many years Manager of the Mining Department of the Fulton Iron Works, of San Francisco, Cal. has, owing to ill-health, severed his connection with that house.

Mr. Charles W. Ehlers has been appointed Superintendent of the Bureau of Engineering and Surveys of Allegheny City, Pa., to succeed his father, Charles Ehlers, whose death was mentioned in our last week's issue.

Mr. Harold Hastings Sanderson and Miss Catherine Osgood were married Jan. 19 at Denver, Colo. Mr. Sanderson is a civil engineer and superintendent of mines at Lafayette, Colo., and the young couple will make their home at that place.

Mr. P. A. Beatty, who went to Bolivia some time ago, to make surveys for a railroad, has, owing to personal reasons, been obliged to return to this country, and is now in the employ of the Baltimore & Ohio R. R., as an Assistant Engineer.

Mr. Alfred L. Hartridge, of Savannah, Ga., at present Chief Engineer of the Kansas City, Burlingame & Western Ry., has been appointed to the position of Chief Engineer of the Kansas City, Ottawa & Burlington R. R., with headquarters at Olathe, Kan.

Mr. H. M. Hedges, lately Assistant Engineer on track elevation for the Chicago, Milwaukee & St. Paul Ry., has been appointed Secretary, Superintendent and Engineer for the Pioneer Irrigation District, and will make his headquarters at Caldwell, Idaho.

Mr. William Pierson Judson, M. Am. Soc. C. E., whose resignation as Deputy New York State Engineer was mentioned in these columns a short time ago, has opened an office at Broadalbin, Fulton County, New York, and will devote his time to his practice as Consulting Engineer.

Mr. R. B. Stratton is stated to have resigned as Chief Engineer of the Portland & Rumford Falls Ry., and of the Rumford Falls & Rangeley Lakes R. R., and will, it is understood, devote his time to the interests of the C. H. McKenzie Co., of Rumford Falls, Me., of which concern he is a member.

Mr. John M. Diven has tendered his resignation as Secretary-Treasurer of the Elmira Water, Light & Railroad Co., of Elmira, N. Y., and as Superintendent of the water-works system of that company, and will go to Charleston, S. C., where he is to become General Manager of the Charleston Light & Water Co.

Mr. Harrison Clement and Mr. V. P. Strange have opened offices at 307 Dooly Block, Salt Lake City, Utah, under the firm name of Clement and Strange, Engineers and Contractors. Mr. Clement for the past three years has been Mining and Mechanical Engineer for the Bingham Consolidated Mining & Smelting Co., and Mr. Strange has been practicing as a consulting mining engineer.

Mr. E. S. Von Piontkowski has resigned his position as Resident Engineer of the Mexican Central Ry., at Aguascalientes, Mexico, to accept the appointment of Chief Engineer of the United Railways of Yucatan, with headquarters at Merida, Mexico. Mr. Piontkowski had been with the Mexican Central Ry. since 1896, with the exception of one year, when he held the position of Chief Engineer of the Pan-American road.

Mr. Charles H. Baker, M. Am. Soc. C. E., founder of the Snoqualmie Falls Power Co., of Seattle and Tacoma, Wash., and since its beginning six years ago the active President and Chief Engineer thereof, and who also, as Manager and Chief Engineer, has promoted and planned the White River Power Co., has sold a controlling interest in both companies to a party of capitalists, who have elected N. H. Latimer, Manager of the Dexter Horton Bank of Seattle, Wash., President. Mr. Baker is planning an early trip to Japan and China for pleasure and rest, and for the purpose of exploring the water-power and electrical possibilities of these countries.

Mr. W. W. Maclay, for the past twelve years President and General Manager of the Glens Falls Portland Cement Co., of Glens Falls, N. Y., has resigned those positions, and henceforth will be able to devote his entire time to his consulting practice on all subjects relating to the manufacture of Portland cement and its uses. He can be addressed for the present at Glens Falls, N. Y. Mr. George F. Bayle, to whom Mr. Maclay has sold his interest in the above-mentioned company, has been elected President. Mr. Maclay has also resigned as member of the Executive Committee of the Association of Portland Cement Manufacturers.

Mr. Edmund M. Blake, a civil engineer associated with Percy M. Blake, of Newton, Mass., left for Italy Jan. 28th, for a tour of inspection of public and engineering works abroad. Mr. Blake has received from the U. S. Department of Agriculture, through Mr. Elwood Mead, Chief of the Irrigation and Drainage Investigations, an honorary commission to make some studies of the Marzano Canal near Cremona, and the drainage works along the Adriatic near Rovigo, with instructions to report to the Department his observations as to ways and means adopted and the extent of the work done and its effectiveness. Mr. Blake will return to this country and resume his practice about May 1.

Mr. S. A. Charles, for more than twenty years Engineer and Superintendent of the company owning the water-works at Lexington, Ky., will retire from that position on Feb. 1, owing to a change in the ownership of the stock of the company. As many of our readers know, through articles by Mr. Charles published in Engineering News, and papers read by him before the American Water-works Association, Mr. Charles has done some very interesting work at Lexington, including the installation and operation of aeration and filtration works and the metering of 99% of the water consumers. Before going to Lexington Mr. Charles was for two years City Engineer of Covington, Ky., and he was at one time engaged on canal and hydraulic work in New York State.

Mr. W. N. Stevens, for some time Assistant Mechanical Engineer of the Rapid Transit Subway Construction Co., of New York City, has accepted a position with J. G. White & Co., of 43 Exchange Place, New York. Mr. Stevens has had a wide experience as a constructing engineer in the designing and active construction of important power plants. He had much to do with the design and construction of the Twelfth St. power-house of New York Edison Co. He also has had charge of the design and construction of the mechanical equipment of the Seventy-fourth St. power-house, and has lately been engaged on the work of designing and building the Fifty-ninth St. power-house, nine transformer stations, car barns, shops, and other adjuncts to the construction and equipment of the Rapid Transit Railroad in New York City. During his professional career Mr. Stevens has also been engaged in engineering undertakings in other parts of this country and abroad, he having made both the preliminary and afterwards the final plans for the machinery of the power-house for the tramways of Sydney, Australia.

Mr. W. Elwell Goldsborough, M. Am. Inst. Elec. Engrs., Director of the School of Electrical Engineering, of Purdue University, who has, during the past three years, held the position of Chief of the Department of Electricity at the Louisiana Purchase Exposition, has become associated with J. G. White & Co., of New York City. Mr. Goldsborough will ultimately be permanently located in New York. For the present, however, his time will be divided between Lafayette, Ind., and New York City. Incidentally, Professor Goldsborough is still giving attention to the matter of closing up the affairs of the Electric Department of the Exposition, which will necessitate his being in St. Louis at times during the next month or so. Professor Goldsborough was graduated from Cornell University in 1892 with the degree of M. E. During the ensuing year he was Electrical Engineer for the Colliery Engineering Co., of Scranton, Pa., and in 1893-1894, he was in charge of the Department of Electrical Engineering of Arkansas University. In 1894-1896 he was Associate Professor of Electrical Engineering at Purdue University, becoming Professor of that department in 1896 and continuing as such until 1898, when, in addition to his duties as Professor, he was made Director of the Electrical Laboratory.

Obituary.

Stephen C. Taft, a civil engineer of Franklin, Mass., died Jan. 23 in that town, of consumption. He was 78 years old.

John M. Hall, formerly President of the New York, New Haven & Hartford R. R., died Jan. 27 in New Haven, Conn., aged 63 years.

Charles L. Treadway, formerly President of the Bristol Water-works Co., and the Bristol & Plainville Tramway Co., of Bristol, Conn., died Jan. 27, aged 57 years.

George Evertson Woodward, at one time Chief Engineer of the Chicago, Milwaukee & St. Paul R. R., died Jan. 26

at his home in New York City, aged 76 years. He was the author of several books on architecture.

Capt. W. F. Van Buskirk, Assistant City Engineer of Winnipeg, Man., died Jan. 15 at Stratford, Ont. Captain Van Buskirk was formerly engaged on engineering work at Orange, Mass., and later was appointed City Engineer of Stratford, Ont., a position he held until he accepted the City Engineership of Rossland, B. C. He was 42 years old.

James Augustine Tiernan, formerly Assistant City Engineer of St. Louis, Mo., died in that city recently, as the result of an injury to the spine, sustained some eight months ago by a fall on a defective sidewalk. At the time of the accident, which ultimately resulted in his death, Mr. Tiernan was connected with the engineering department, under the Street Commissioners, and previous to that he had been in the engineering department of the Missouri Pacific Ry.

William Sellers, founder of the firm of William Sellers & Co., of Philadelphia, Pa., manufacturers of machine tools, died Jan. 24 at the University Hospital in that city. William Sellers was born in 1824, and when 14 years old was apprenticed to his uncle, who conducted a machine shop. He remained with his uncle until 1845, when he went to Providence, R. I., to take charge of the shops of Bancroft, Nightingale & Co., manufacturers of steam engines and mill gearing. Two years later he returned to West Philadelphia and began a similar department of manufacturing on his own account. Mr. Bancroft, one of his former employers, was taken into partnership, the firm name becoming Bancroft & Sellers, and existing as such until the death of Mr. Bancroft in 1855. Previous to this John Sellers, Jr., had been taken into the concern, and the firm name now became William Sellers & Co. In 1868 Mr. Sellers organized the Edgemoor Iron Co. Five years later he became President of the Midvale Steel Co., which he subsequently reorganized. Mr. Sellers was President of the Franklin Institute in 1864, and while occupying this position proposed what is said to be the first formula ever offered for a system of screw threads and nuts, and which eventually became the standard for the United States. He was a member of the National Academy of Sciences, and in 1874 he was made a corresponding member of the Paris Société d'Encouragement pour l'Industrie Nationale.

John Kenneth Mackenzie, a well-known mining engineer of Chicago, Ill., was killed by Indians in the State of Sonora, four miles east of Cobachi, Mexico. Mr. Mackenzie, who was a member of the firm of Dickman, Mackenzie & Potter, Mining Engineers, in company with Dr. Robert C. Coy, a dentist of Chicago, who is also said to have been killed, left that city Jan. 8 to inspect mining properties in the State of Sonora. It seems that a party, of which Mr. Mackenzie and Mr. Coy were members, went to Camp Toledo, 75 miles east of La Colorado, to examine properties owned by a Chicago syndicate. The party left Camp Toledo Jan. 18 in two four-horse stages on their return trip to La Colorado. Coy, Mackenzie and H. L. Miller, of Chicago, were in the first stage, which was driven by a Mexican. In the second stage were M. A. Call, of Toledo, O.; Walter Stubinger, of Kewanee, Ill.; A. W. Tarleton, of Salem, O., and a Mexican driver. The party had just emerged from the hills, and were entering the flat country, when, without the least warning, a volley of rifle shots was poured into the first stage from behind a pile of rocks on the roadside. One of the horses attached to the stage fell, and the vehicle was brought to a sudden stop. Coy, Mackenzie and the driver were killed almost instantly, and the Indians fired another volley into the second vehicle, where Call and Stubinger were shot dead. Miller, Tarleton and the driver drew their guns, and, making a running fight, fled toward Cobachi, where they arrived that evening. Mackenzie was shot through the head and Coy through the body. A party was organized at Cobachi, which, after failing to overtake the Yaquis, returned with the bodies of the dead men.

Edward Hemphill Mullin, M. Am. Inst. Elec. Engrs., confidential representative of the General Electric Co., died suddenly at his home in Milburn, N. J., Jan. 25, from an attack of heart disease. Mr. Mullin was born in Castlederg, County Tyrone, Ireland, in 1859, and was educated at the Methodist College Public School of Belfast, and the Queen's College, Belfast, where he took his Bachelor's degree with honors in Physics and Chemistry in 1881. Shortly afterwards he came to New York, and engaged in newspaper work. From 1887 to 1895 he was an editorial writer on the staff of the New York Evening Sun. The two following years he spent on the staff of the New York Times, in charge of the technical reporting of that newspaper. Subsequently he became editor of the Bookbuyer and a prolific contributor to the magazine and technical press. In 1898 he entered the service of the General Electric Co., at first as Manager of its Advertising Department and latterly as a confidential representative of the company in many matters. He was the authorized representative of the company in all relations with the press, and the official host of the company whenever foreign engineers or capitalists desired to visit the works or become acquainted with its methods. Mr. Mullin was a thirty-second degree Mason and a member of the Engineers, Press, Lotus and Transportation Clubs. He was Vice-President of the New York Electrical Society and a Director of the American Institute of Electrical Engineers, also Vice-President of the Association of American Advertisers. At a meeting of the Directors of the American Institute of Electrical Engineers, resolutions of sympathy were adopted, and the board voted to attend the funeral in a body.

ENGINEERING SOCIETIES.

COMING MEETINGS.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Jan. 30 to Feb. 11, 1905. Annual meeting at Birmingham, Ala.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 28, 1905. Annual meeting at Toronto, Ont. Secy., Killaly Gamble, Temple Bldg., Toronto.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 21, 22, 23. Annual meeting at Chicago. Secy., L. C. Fritch, 1562 Monadnock Block, Chicago.

AMERICAN ELECTROCHEMICAL SOCIETY.
April 25 to 27. Annual meeting at Boston and Cambridge, Mass. Secy., S. S. Sadtler, 39 S. 10th St., Philadelphia, Pa.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The February meeting will be held at Tremont Tempie, Boston, Mass., at 2 p. m., of Feb. 8, 1905. Two papers will be presented: "The Maine Water District and Appraisals," by Mr. H. D. Eaton, of Waterville, Me.; and "The Kennebec Valley Typhoid Fever Epidemic of 1902-1903," by Dr. G. C. Whipple and Mr. E. C. Levy.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting of Feb. 4, 1905, Mr. John W. Hill will present a paper "Examination of the Torresdale Conduit," which will be illustrated by lantern slides.

The election of officers at the club's annual meeting, Jan. 21, resulted as follows: President, Mr. S. G. Comfort; Vice-President, Mr. J. B. King; Treasurer, Mr. G. T. Gwilliam; Secretary, Mr. W. L. Webb.

BROOKLYN ENGINEERS' CLUB.—At the next meeting of the club, to be held on Thursday evening, Feb. 9, at the club rooms, 197 Montague St., Brooklyn, Mr. R. C. Strachan will read a paper "The Computation of Stresses in the Blackwell's Island Bridge." As may be remembered from our description of the designs for this bridge a year ago, the structure is to be a hinged double cantilever girder, being like an ordinary cantilever structure with a suspended span of zero length and with the two cantilever arms pinned together against vertical play. The structure is thus statically indeterminate, and its stresses must be analyzed like those of an elastic arch.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—At the meeting of Jan. 27, 1905, held at 1354 W. 57th St., New York City, Mr. J. E. Noeggerath read a paper on "Acyclic or Homopolar Dynamos," in which he discussed some of the elements of design of unipolar machines, and described a 300-KW. 500-volt machine which has been built at Schenectady, N. Y., for direct driving by a steam turbine. Mr. I. E. Moultrop, of Boston, Mass., read a paper on "The New Turbo-Generator Station of the Edison Electric Illuminating Company of Boston," which described the layout and planning of the station in extenso. The station is planned for six 5,000-KW. units, consisting of three-phase generators driven by Curtis steam turbines. Both papers awakened a brisk discussion.

FIRST ANNUAL CEMENT USERS' CONVENTION.—The National Association of Cement Users held its first annual convention in the Claypool Hotel Auditorium, Indianapolis, Jan. 17 and 18. Nearly five hundred cement people from all parts of the country were present, at least half of the states being represented. The eighth floor rooms of the hotel as well as the auditorium were given up to exhibitors and their numerous machines. It was said that a greater number of machines for making cement blocks, cement brick, columns, posts, shingles, cisterns, tile, etc., were exhibited than were shown at the St. Louis Exposition. The convention was presided over by Mr. J. P. Given, of Circleville, O.; Mr. C. C. Brown, of Indianapolis, acted as secretary. A constitution was adopted, and the organization perfected. Three sessions were held daily. The programme of papers and subjects has already been printed in this column. All of the papers aroused a healthy discussion, and brought out an exchange of ideas and experiences that gave the convention an animated spirit from start to finish. A question box was used and opened at intervals, and found to contain a number of puzzling inquiries directed to the large number of experts present. This proved to be an interesting feature of the convention. The exhibition of machines and materials used in cement and concrete work and the practical operation of many of them attracted much interest and attention. The convention, as a whole, was a great success. The roll of members exceeds 400. The next convention will be held in Milwaukee, Wis. The following officers were elected: President, R. L. Humphrey, of Philadelphia, Pa.; Vice-Presidents, A. L. Goetzmann, of Chicago, Ill., J. H. Fellows of Scranton, Pa., H. C. Quinn of Georgia, A. Monsted of Milwaukee, Wis.; Secretary, C. C. Brown, of Indianapolis, Ind.

ANNUAL MEETING, OHIO ENGINEERING SOCIETY.—The 26th annual meeting of this society was held at the Great Southern Hotel, Columbus, Ohio, on Jan. 23 to 25, 1905. The meeting was the most largely attended for several years and a most encouraging revival of interest and enthusiasm was evident throughout the meeting. The report of the Secretary showed a large increase of membership and a satisfactory financial condition. Including applicants elected at this meeting the membership has doubled in the past year.

Addresses were made by Hon. Wade H. Ellis, Attorney-General of Ohio; Hon. Robert H. Jeffrey, Mayor of Columbus, and J. W. Payne, City Engineer, Akron, O., retiring President.

Technical papers were read as follows: "Highways," by J. W. Turner, County Surveyor, Jackson; "Proposed Improvements in Water Supply and Sewerage at Columbus," by E. A. Kemmler, Asst. City Engineer, Columbus; "Experimental Work in Sewage Disposal at Columbus," by G. A. Johnson, Engineer in Charge, Columbus Sewage Testing Station; "The Co-operative Topographical Survey of Ohio," by Prof. C. E. Sherman, Ohio State University; "Street Railway Tracks and Pavements," by J. M. Harper, Chief Engineer, Interurban Ry. & Terminal Co., Cincinnati; "The Common Roads of Ohio," by J. F. Brown, Special Agent, Dept. of Road Inquiries; "The Building of the C. C. & L. Railroad," by F. R. Charles, Richmond, Ind.; "Cement or Concrete Roadways," by H. L. Weber, City Engr., Richmond, Ind.; "The Reservoir System at the Headwaters of the Mississippi River," by Prof. B. E. Trask, Denison University, Granville; "Stream Gaging in Ohio by the State Board of Health and the U. S. Geological Survey," by R. W. Pratt, Engr. State Board of Health; "A Three-Hinged Concrete Steel Arched Bridge," by L. A. Keith, City Engineer, Mansfield; "Hugh Baird, A Historical Sketch of Ye Old Tyme Surveyor," by Homer C. White, County Surveyor, Warren; "Reinforced Concrete Retaining Walls," by P. A. Bone, U. S. Engineer, Cincinnati; "The National Pike," by J. H. Asher, County Surveyor, London; "Some Phases of Sewage Disposal," by Frank A. Barbour, Boston, Mass.

Following Mr. Pratt's paper Mr. M. O. Leighton, Chief of the Division of Hydro-Economics, U. S. Geological Survey, gave an outline of the work of his department. Mr. Barbour exhibited lantern slides of several modern sewage disposal plants. The society visited the Columbus Sewage Testing Station where the various methods of purification under consideration were explained by Mr. G. A. Johnson, Engineer in Charge; Mr. A. E. Kimberly, Chemist; Mr. W. R. Copeland, Bacteriologist, and Mr. Shute, Assistant Engineer.

By a unanimous vote the name of the society was changed from Ohio Society of Surveyors and Civil Engineers, to Ohio Engineering Society. Officers were elected as follows for the ensuing year: President, Mr. Paul R. Murray, of New Philadelphia; Vice-President, Mr. E. A. Kemmler, Asst. City Engr., of Columbus; Secretary and Treasurer, Mr. E. G. Bradbury, of Columbus.

AMERICAN ELECTROCHEMICAL SOCIETY.—The New York section of the society held its first meeting of the present winter at the Chemists' Club, 108 W. 55th St., New York, on Jan. 24, 1905. Mr. E. F. Roeber read a long paper on "The State of the Art of Electrometallurgy of Iron," wherein he discussed all the various points of contact between iron and steel metallurgy and electricity. He credited the slump of the calcium carbide industry in Europe with being the stimulus toward experiments in refining iron and making ferro-alloys in the electric furnace. The electric furnace is the only promising possibility in iron working, to the entire exclusion of electrolytic processes. The latter are even less applicable in the case of iron than in the case of impure copper. However, there may be some future in the electrolytic production of pure iron, in which field some experimental work has recently been done. The electric furnace may be considered in relation to four fields of production: 1, ferro-alloys; 2, high-grade steels; 3, structural steels, and, 4, iron from ore direct. In the first two fields, the electric furnace already has an assured place, though only in the first is it in a commercial place. As to structural steel, it is concluded that the electric furnace has at present no chance to compete with Bessemer and open-hearth furnaces; but it is suggested that there may be a future in electric production of higher grade steels to take the place of modern structural steel. Moreover, there is some possibility in a suggestion of Prof. Richards, to add the last few hundred degrees to the open-hearth furnace charge by electric current. In iron smelting the conditions are not favorable to electric reduction. In very extreme conditions the method may have some utility. No commercial electric iron-smelting plant exists to-day. Mr. J. T. Morehead, in discussion, stated that the Willson Aluminum Co. is producing large quantities of ferro-chrome, -vanadian, -tungsten, and -molybdenum by electric work. The company is producing power from its own water-power plant at $7½ to $9 per HP.-year, including the interest on investment.

Mr. G. F. Kunz reported that Professor Moissan has found carborundum particles in iron meteorites found in Canon Diablo, Arizona. Carborundum or silicon carbide is thus placed in the class of natural minerals. It is proposed to name it after its discoverer, Prof. Moissan. It is thought, from the discovery, that these meteorites are of volcanic origin.